Compressed Air Magazine

MARCH 1943

P-39 FIGHTER

Tracer bullets show the fire power of the U.S. Airacobra.

VOLUME 48 · NUMBER 3

NEW YORK · LONDON

ON THE COVER

OUR cover picture shows one of our most powerful aerial instruments of destruction. The Bell Aircraft Corporation, maker of the Airacobra, advertises it as "the hardest-hitting single-engine fighter in the world." Developed in conjunction with the Army Air Force, it is of new design from nose to tail. It has a cannon in the nose, and four machine guns—two forward, at the top of the fuselage, and one in either wing. The engine is located behind the pilot's station. P-39's are in combat service on all the fighting fronts.

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IN THIS ISSUE

ALTHOUGH they were introduced only five years ago, hundreds of small air-operated hoists are now pulling scrapers laden with ore in narrow-stope mines and performing various auxiliary services. The result is more production per shift and per man. Our leading article describes their use and gives an idea of their great adaptability.

•

IN THE article on the Mont Cenis Tunnel we believe we have brought to light interesting details concerning the first use of compressed air and air-operated rock drills on a large construction job.

•

BLACKIE Brechbuelle, central figure in *Portrait of an Old Timer*, typifies the western mining man of yesteryear. There are scores of others like him, who, despite advanced years, still go underground to earn a living.

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CONSERVATION of material is in everyone's mind these days. Consequently, the short article showing savings in sheet material of different kinds through careful patterning before cutting should be of interest.

Compressed Air Magazine

VOLUME 48 **March, 1943** NUMBER 3

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EDITORIAL CONTENTS

ADVERTISING INDEX

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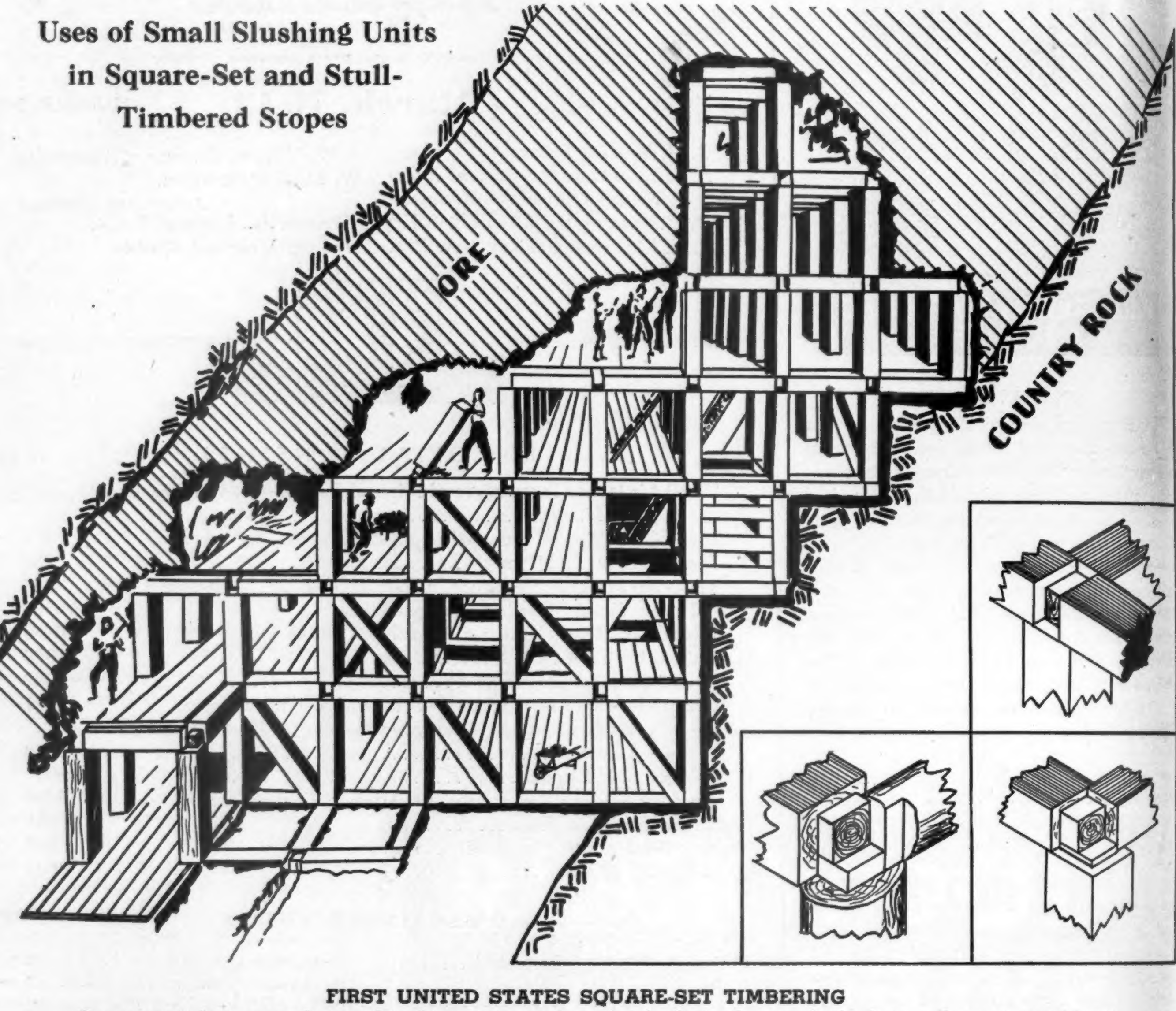
Small Air Hoists Increase Vital Mineral Output

R. V. Pierce and R. N. Bryan

Uses of Small Slushing Units in Square-Set and Stull-Timbered Stopes



FIRST UNITED STATES SQUARE-SET TIMBERING

Square-set timbering was first used in this country on the fabulously rich Comstock Lode, which produced $36,000,000 in silver in a single year—1878. This sketch is a reproduction of part of a drawing prepared in 1876 by T. L. Dawes and put out by J. B. Marshall of Gold Hill, Nev., to illustrate mining methods at the Ophir, one of the richest properties. It wil be noted that all operations were done by hand. Curiously enough, the first small experimental hoist of the line that is now increasing the output from square-set stopes was tried out in a mine in this section. The framing of the ends of timbers in square sets varies considerably, and each mine uses the one that best meets working conditions. Three different types are shown at the lower right.

IN A previous article, titled *Scraping and Loading in Mines* (C.A.M., June, 1942), we discussed the development of the scraper hoist and its place in modern mining. The article was, as the reader may recall, very general in scope. We now propose to take up a specific system—namely, square-set stoping—and to discuss and to illustrate a few applications of scraper hoists in this field.

According to the late Robert Peele, eminent authority on mining practices, square-set stoping was first used in the United States by Philip Deidesheimer at the Ophir Mine on the Comstock Lode in Nevada and was, for many years, called the Nevada square-set system. The method obtains its name from the fact that square-set timbering is placed to support the ground as the ore is taken out. Generally speaking, the stope is advanced by small excavations, each of which is timbered before the next one is started. After the ore has been shot out, a square-set frame is erected in the newly opened space.

Each frame is a hollow-sided box made by setting a post at each corner and connecting them at the top with four horizontal timbers. Two of the connecting members running parallel to each other are known as caps, and the other two which are at right angles to the caps are termed girts. In drifts and crosscuts the caps are the transverse members and the girts the longitudinal ones. In larger openings, the caps extend in the direction of the greatest lateral pressure. Consequently, they are often called upon to do more supporting than the girts and may be larger than the latter. Posts are commonly about 7 feet high and are set 5½ feet apart, center to center, both capwise and girtwise, their plan pattern forming a square. Timbers in adjoining sections are framed into one another and offer common support. In large mines the pieces are generally framed on the surface so

THEY WORK ANYWHERE

Three views showing scraper hoists working in narrow stopes where bulky, heavy equipment can be used only with great difficulty, if at all. In two of the pictures a loaded scraper is being pulled to a chute that is located just in front of the hoist.

that they are ready for assembling when they go underground. The size of the timbers varies with the firmness of the rock, dimensions of the stope, and other factors, and may range from 8 to 12, or sometimes even 24 inches in cross section.

As square-set timbering is carried upward in a stope to keep pace with the mining of the overhead ore body, the posts of each succeeding vertical set are placed directly on top of those of the set immediately below. Thus the corner uprights form a continuous column from bottom to top, and the caps and girts are in the same respective vertical planes, the construction pattern being similar to that of the steel framework of a skyscraper.

The square sets support the walls of the stope, and plank flooring or lagging is laid on top of the caps or girts at suitable levels to provide support for broken ore and working platforms for the men. The highest working floor is the mining floor, and broken material is shot down to the next one below, which is the wheel or mucking floor. Sometimes, timber sets alone are relied upon to support the walls of the worked-out area, and the result is an open square-set stope. More often, waste rock or mill tailings are periodically run into the lower sets as mining proceeds upward, and this is called a filled square-set stope. The filled space is known as the gob.

Square-set stoping is widely practiced and may be considered one of the most important of the mining systems. It is used, at least to some extent, in the extraction of the ores of practically all the principal commercial metals, as well as of several nonmetallic minerals. Although no production figures are available, it can be said that a vast quantity of mineral wealth is mined by the square-set procedure, and that virtually all the materials so recovered are needed in the war effort. It is obvious, then, that anything that will increase the per-man output of mines of this type will make an important contribution towards our national economy. Scraper-mucking does this.

The application of mechanical-scraping methods to the square-set stoping system is not strictly new, but the greatest advance and the most telling results have been registered during the past five years. This has been attributable primarily to the development of a small, lightweight, 2-drum, air-operated hoist that can be quickly and cheaply moved and easily mounted in various ways to meet local conditions. It can be said, in general, that one of these hoists can be profitably employed in any location customarily served by a wheelbarrow. The unit weighs only 250 pounds, or less than half as much as the smallest slushing hoist that was available prior to 1938.

Numerous advantages can be gained by applying scraper-mucking to this system of mining. As many as four faces can be worked simultaneously in one block of ground, thereby speeding up extraction where physical conditions, shortage of manpower, and safety precautions limit operations by hand methods to one face at a time. Fewer men are required per ton of ore produced, and this is a matter of paramount consideration at present. Moreover, scraper-mucking takes a lot of the backache out of mining. Hand-mucking calls for physical strength and endurance, and needs the kind of man that right now is in demand for service in the armed forces. By contrast, the duties of a hoist operator are so simple and easily learned and so free from laborious effort that they can be readily performed either by a young, comparatively inexperienced worker or by a veteran miner who is past his physical prime. The employment of one or the other, or both of these types, as slusherman permits assigning experienced, robust men to the drilling faces.

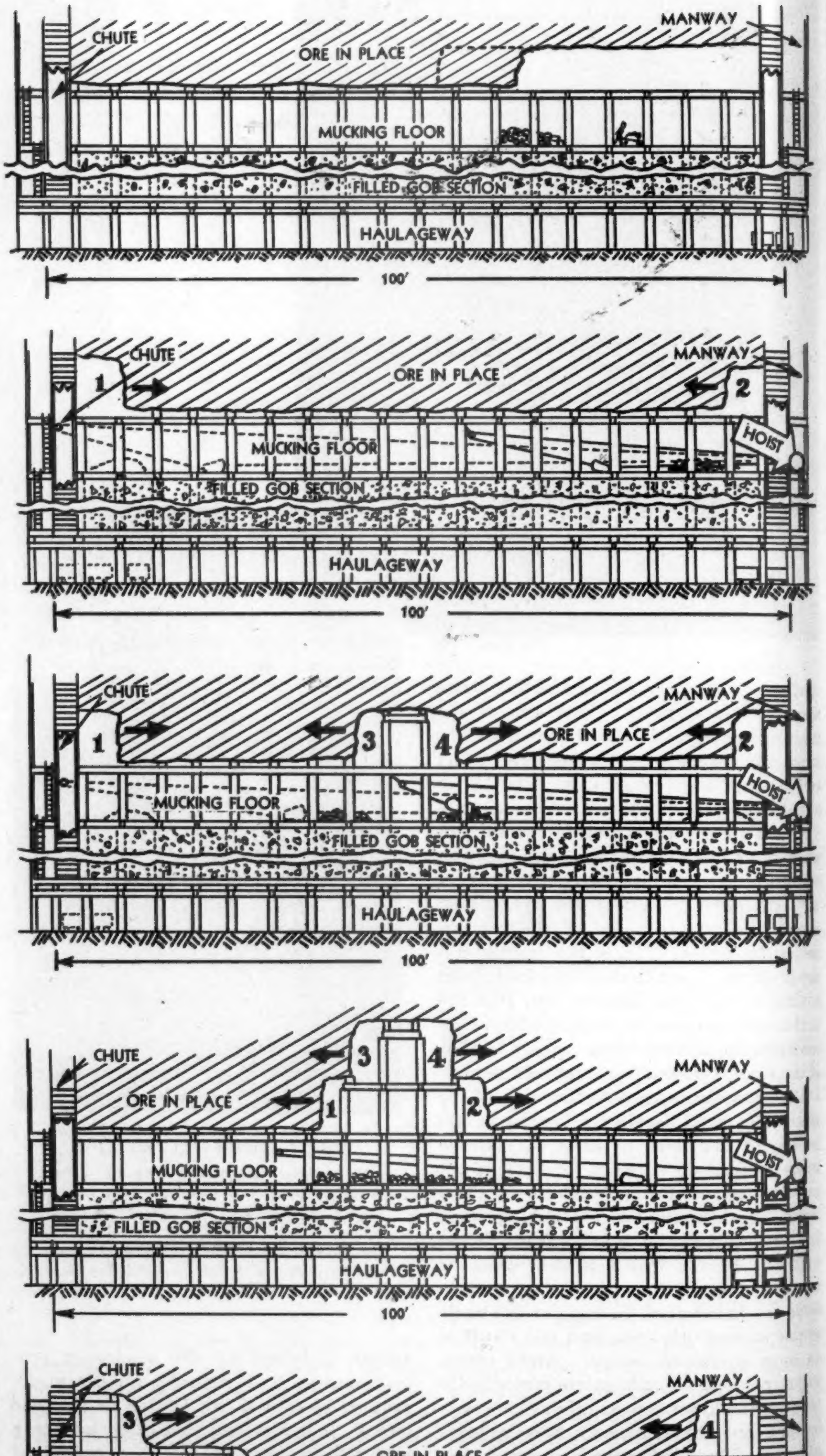
By speeding up the extraction of ore, several secondary but important benefits are derived from scraper-mucking. In filled stopes, which predominate, it is customary when moving muck in wheelbarrows to have no more than four floors of timbering open at one time and then to

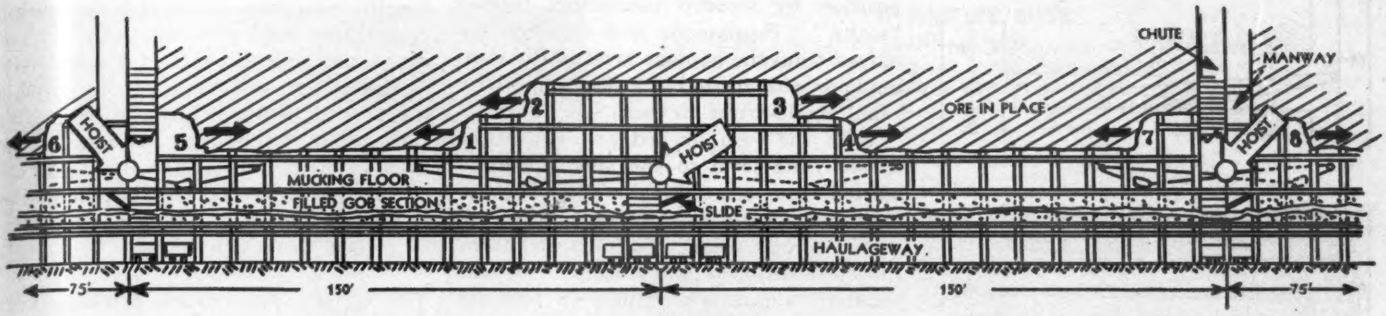
fill them with waste to provide additional support for the walls. However, faster mining often makes it possible to open ground for five floors before the formation reaches a stage of such "heaviness" as to require filling of the lower floors. For the same reason, the work of timber maintenance is reduced, and it will frequently be found that less over-all timbering will be needed. Or, faster mining may permit increasing the length of the blocks. For example, where an ore deposit ordinarily is laid out in blocks 100 feet long, scraper-mucking may allow the distance to be increased to 150 feet. This will lead to a reduction in the number of raises that will have to be driven, and thus save appreciable sums of money, for raise work is one of the costliest operations in mining.

In this connection, it should be pointed out that the best and the most economical results will be obtained from scraper-mucking where mining is planned so as to realize its advantages to the fullest. Lesser benefits will be derived from its adoption where it must be fitted into existing methods. Because of the great variation in conditions and limiting circumstances existing in individual mines, it is difficult to estimate the advantages that will accrue to the average property through the substitution of scrapers for hand-loading. It can be conservatively stated, however, that, under favorable conditions, the speed of mining may be increased as much as four times and the cost may be cut in half. In general, a hoist-scraper arrangement of the size under discussion will move from 12 to 17 tons an hour over a distance of 50 feet, and from 8 to 10 tons an hour over distances ranging from 85 to 100 feet. Its hourly capacity is equivalent, roughly, to the tonnage a man will load and transport by wheelbarrow during a shift.

It should be borne in mind that these small hoists have time-saving and cost-reducing applications other than those incident to moving ore. They can be used to advantage in spreading fill in timber sets and for handling timbers and other materials, as well as equipment, in raises. Sometimes all these services can be performed from one set-up, but where they cannot, the lightness and easy portability of the hoist, which are among its greatest assets, facilitate operations. With the hoists previously available, so much time was consumed in shifting them and setting them up that the resultant benefits were partially or wholly nullified. One of the current models can often be made to drag itself on a skid to a new location under its own power. Whenever it is necessary to move it manually, it can be readily handled by two men, and it lends itself to such a variety of mountings that it can be adapted to almost any set of conditions encountered in the square-set stoping system of mining.

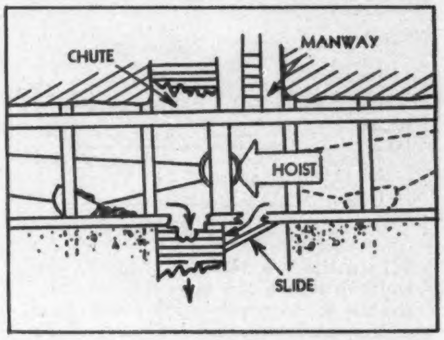
Numerous mines have already adopted these lightweight hoists, and they are





HOW SCRAPER-MUCKING SPEEDS UP MINING

These longitudinal sketches illustrate some of the ore-breaking and mucking set-ups that can be used in connection with lightweight hoists in square-set stopes. The top drawing on the opposite page shows the usual method of mining at one face only when a wheelbarrow serves to transport ore to the chute. The second sketch indicates how two faces may be worked with a hoist-scraper combination. The three others illustrate different ways in which four faces may be mined and the ore moved with one hoist. The drawing on this page shows a 3-hoist installation for working a block of ground 450 feet long. As mining proceeds, and the gob section is filled with waste, the raise at the center is carried upward. Solid and dotted lines in all the sketches show the different mucking set-ups that can be obtained by moving the sheave blocks. Without changing the hoist location it is possible to pull muck to the nearest chute, thus cutting down the haul. In the set-up above, each of the three hoists is mounted on a turntable so that it can muck from either direction. Details of the hoist mounting are pictured at the right.



being used in the production of ores of lead, zinc, copper, molybdenum, tungsten, mercury, manganese, chromium, aluminum, and vanadium; the siliceous ores of gold and silver; and nonmetallic minerals, including gypsum, phosphate, fluorspar, and coal. These mechanical aids are helping to maintain the output of vitally needed materials of war despite the handicaps that have been imposed upon the mining industry by the shortage of manpower, especially of the type that is required at the working faces. Some of the mines offer splendid examples of operations by the square-set stoping system, or variations of it. Three such properties will be discussed here to show how they are utilizing the hoists and what they are accomplishing with them. All are located in the western part of the country, and the material concerning them is made available through the coöperation of their managements.

Mine "A"

THIS property produces tungsten and gold and is characterized by extremely heavy ground and a very irregular ore body. Standard square-set stoping is used. The ore exists in shear zones, which average 60 feet in width and vary from 25 to 100 feet. It usually lies along one wall of a shear zone, but may be found along both walls; ranges in width from 2 to 10 feet; and is most irregular—there being considerable faulting, cross-faulting, and splits that do not follow any particular pattern. The entire zone, and especially that part containing the ore, is extremely heavy. There are sections where side- and back-spiling have had to be used to open an area and to hold it open long enough to complete mining before filling would take place. The ore, once it is broken, is fairly fine; there are very few chunks of large size in the muck piles that require handling.

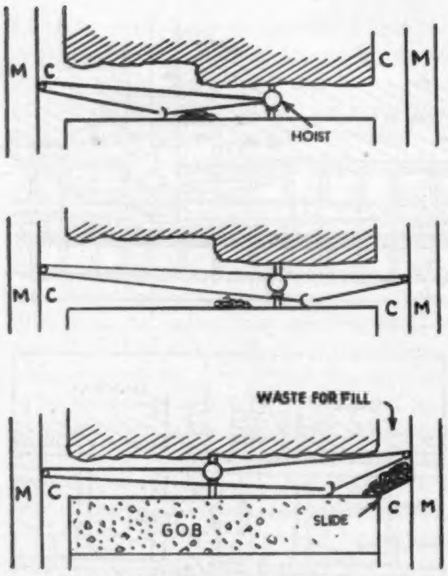
The levels are advanced from a vertical shaft at 100-foot intervals, and drifts are ordinarily 8x9 or 8x10 feet in cross section. It is usually not necessary to timber the drifts, for these are driven in the walls bounding the shear zones. However, when a drift enters a shear zone, mining must be done with great care and timbering is indispensable. Once a shear zone has been prospected and the course and extent of the ore veins have been determined, raises, on 75-foot centers, are driven from one level to the next higher one. Most of these have two compartments, each with a manway and a chute section. Timbering in the raises follows standard square-set practice, and framing is of the so-called "rocker" type. The chutes are lined with 2- or 3-inch lagging, and the manway includes a ladder and a timber slide for the handling of mining materials. The drifts are timbered with posts cut with a 10-inch frame.

Stoping is carried out by making successive horizontal cuts from one raise section to another. Lead sets of ground are broken with stoper drills. All stope areas are timbered with square sets. One man takes care of the drilling, and nine holes constitute an average round, the steel utilized being 1-inch hexagon provided with detachable bits. About 20 tons of ore, or waste, is broken per round. Ingersoll-Rand A4NN-0J double-drum air hoists are used for mucking the broken material in the stope areas, where a slusherman, with one hoist and a scraper, handles as many as three rounds of ore, or 60 tons, in an 8-hour shift. When waste has to be pulled from a hanging-wall crosscut into the stope for fill, that work also is done by the hoist, which not only delivers it to the stope but spreads it where it is needed. The scraper used for this purpose weighs about 235 pounds. The hoist is mounted either on a horizontal bar—a wooden platform—on a spreader that is placed between posts and is parallel with the caps on the mucking floor or on a vertical bar and arm exactly as is done in the case of a standard drifter set-up. The slusherman is available for moving lagging in and out of the stope; that is, he puts down and shifts his own mucking floor because these operations are done with the aid of the hoist. As a rule, he mucks two rounds a day and, in addition, takes care of the floor and handles waste filling.

It can be seen, therefore, that the uses of a scraper hoist are many and varied. The light weight of the A4NN-0J contributes to this flexibility. It does not take "three men and a boy" to move such a machine. Moreover, a block of ground can be mined out quickly, for the manpower previously required for hand-mucking can be diverted to timbering and drilling. One man with a scraper outfit will do the work of several men using wheelbarrows. Ground that is mined out rapidly has less chance to "take weight," and fewer repairs are necessary on stope timbering and less maintenance work in keeping chutes and manways open.

Mine "B"

THIS is a lead, zinc, and silver property and is among the oldest continuous producers of these metals in the western states. It uses square-set and stull-timber stoping methods. The vein system, for the most part, consists of replacement bodies in limestone. Some of the veins are narrow streaks; others are as much as 8 to 15 feet wide, and their walls are often quite rotten. The footwall is not very troublesome, but it tends to slough, and that necessitates timbering every stope open-



SELECTIVE MINING

Where the ore varies throughout the width or length of a vein, it is often desirable to segregate high-grade from milling-grade ore, and this can be done very easily with the scraper-hoist arrangements pictured here. The hoist is placed wherever desired within the stope and is mounted so that the scraper will pass underneath it. The two upper sketches show how direct-smelting ore may be mucked to the left-hand chute and mill dirt to the right-hand chute. The bottom sketch illustrates how the same set-up may be used for spreading fill drawn through a chute from an upper level. In a similar manner, a hoist may be mounted anywhere within a stope proper to do its work in cases where there is no place for it at either chute, or where stopes are narrow or crooked, or where visibility is limited for some other reason.

ing. Moreover, when the vein is opened and stoping is begun, there are a number of places where butt blocks or cribbing have to be carried over the set until the next cut above this mining floor is started. The ore, being predominantly lead and zinc, is very heavy.

The levels are opened from a vertical shaft at 200-foot intervals, and drifts are driven either timbered or untimbered, depending upon the nature of the ground and the proximity of the vein. Where a crosscut encounters a vein, a drift follows the latter directly along its strike, and it is usually necessary to timber it heavily. Crosscuts, however, do not require much timbering. Once a vein is opened with a prospect drift, raises, spaced at 100-foot intervals, are driven from one level to the next directly above. They are generally of the 3-compartment type, including two chutes and a manway between the chutes. There are cases, however, where one chute and a manway suffice. The raises are supported with square, rough-sawed 10x10-inch timbers. This is a variation of square-set timbering, but there is no framing of tenons. All posts, caps, and girts (or collar braces, as they are called here) are placed flush, face to face, and held in position by wooden connectors termed "scabs." Equipment and supplies are moved from the haulage level to the mining floor with the aid of a steel skip and a small single-drum air hoist.

With the vein opened and the raises driven from level to the level, a cut is started from one raise directly over the drift and is advanced one set high across to the second raise. The material from this cut is dropped onto a lagged floor and through "Chinaman" chutes—a practice which allows the mucker to dump the ore directly into a car on the main haulage level. When the cut is worked out, the wheel floor is established. The latter is built by placing 3-inch lagging from cap to cap and forms a surface on which to drop the ore from the successive cuts excavated above it in the stoping area. In the past, this broken ore was shoveled by hand into wheelbarrows, and these were pushed along the wheel floor and emptied directly into a chute for delivery to the haulage level. It is here that scrapers are now being used in preference to hand-mucking and tramming.

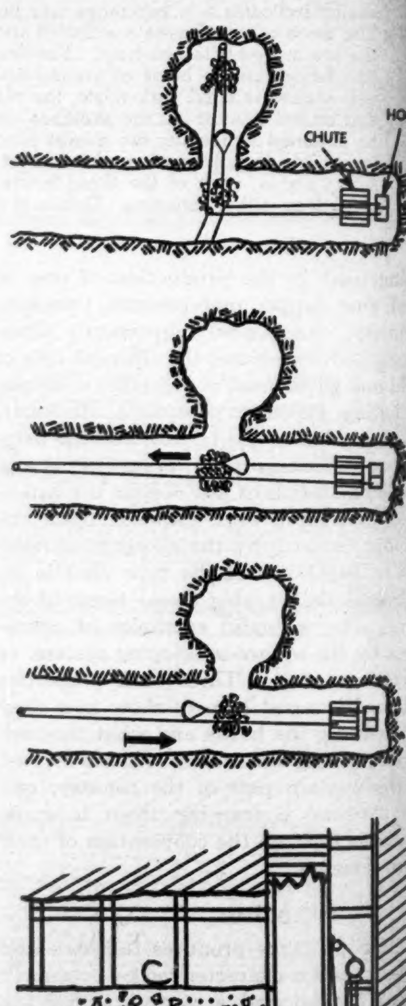
In carrying out the stoping cycle, a miner sets up a vertical column and arm underneath the lead cap of the mining floor and, with the aid of a 3½-inch drill, puts fairly flat slab holes in the unbroken ground ahead. This is blasted so that it will fall to the wheel floor. The cycle runs about the same each day; that is, drilling a round, standing a set of timber, mucking out, and blasting another round going off shift. One man does the drilling. The timbering, which is a variation of square-set work, is handled by another man who, if he needs help, calls upon the scraper operator or the miner.

Because of their light weight and consequent portability, A4NN-0J Ingersoll-Rand double-drum hoists are used for mucking. A 26-inch scraper of the quarter-box hoe type is employed with each hoist. It weighs about 235 pounds and moves approximately 600 pounds of ore per trip. In one of the stopes already completed, the hoist sometimes pulled the scraper a distance of 21 sets, and it was not difficult to get out from 22 to 25 cars of 2½ tons capacity in one shift. In some of the wider sections of the vein a hoist has handled as much as 250 tons of lead-zinc ore in four working shifts.

As an example of what can be accomplished with a small hoist using air at from 75 to 80 pounds pressure, the following is cited: an average of 55 seconds is required for one round trip of the scraper on a 65- to 70-foot pull; that is, to deliver 600 pounds of ore (the equivalent of more than a wheelbarrow load) to the chute. At the present time one man can transport a greater tonnage to the chute than several men were formerly able to move with hand-shoveling methods and a wheelbarrow. Prior to the advent of the scraper, one man did the mining, a timberman and a helper took care of the timbering, and a fourth man was employed as mucker. Now three are adequate. The timberman's helper is available for other work, as the mucker can clean out his round in short order, after which he assists the timberman. In the past, ten wheelbarrow loads of ore had to be handled to fill one of the 2½-ton ore cars. Now, eight trips of a scraper will do it.

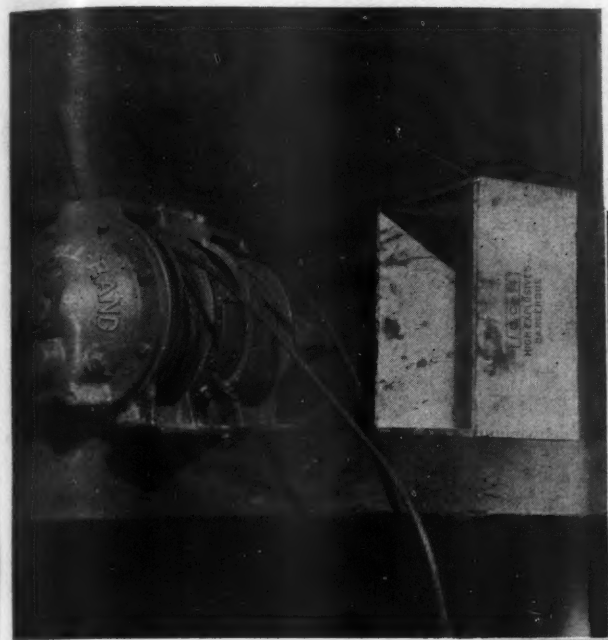
Mine "C"

IN THIS mine, which produces lead, zinc, gold and silver, the main haulage drift generally follows the strike of the ore body. Raises have been driven at 100-foot intervals from this haulageway to the next level, 100 feet above. They have



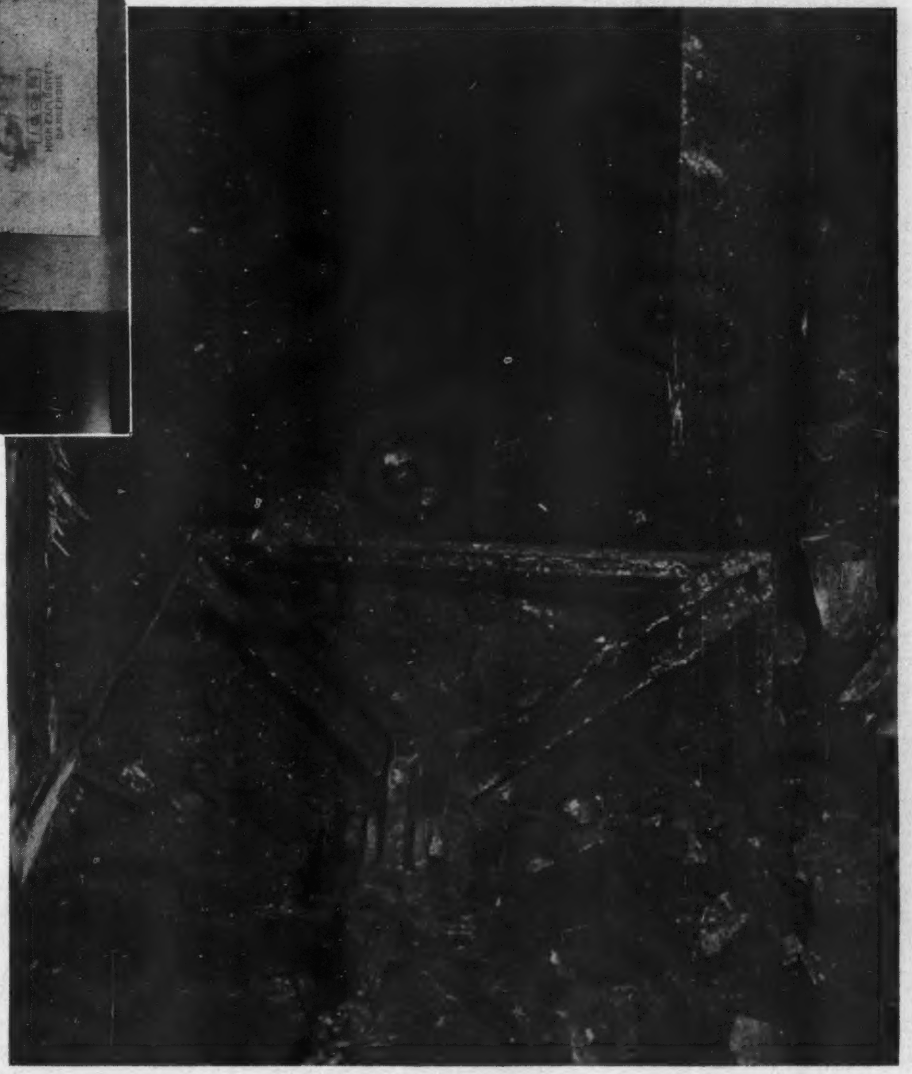
HANDLING FILL AND TIMBER

The three upper drawings show how fill can be drawn from a cross cut in a stope wall and spread in either direction without moving the hoist. The bottom sketch indicates how timber or other material may be handled in a raise with the hoist in the same location as it is for the operations that have just been referred to.



A MIGHTY MITE

The small size of the A4NN-0J hoist, used in many mines for mucking narrow or irregular veins, becomes apparent when viewed in comparison with a powder box (left). The unit will pass through a 13x15-inch opening. Despite its size, it has ample power to handle heavy material, as the scraper picture below indicates.



three compartments, namely, a manway with a chute on each side. Once the raises have been completed, stoping is started from them at each end of the 100-foot ore block and the cuts are advanced horizontally until they meet. Five-foot rounds are drilled, and after each one has been mucked out, a timber set is erected in the space. After the first cut has been finished, a second one is begun directly above it, working from the two ends as before. The square sets are made up of round 4-foot, 4-inch posts that support square-sawed 8x8-inch caps and girts.

The vein stands nearly vertical, and as the 5-foot rounds are blasted the broken ore from each one drops directly on to the lagged floor of the bottom set. After a 4-set-high block has been worked out, the mucking floor is moved up four sets and the mined area is filled with waste that is transferred from the operating level above. This waste comes in at either end of the stope through the raise chutes. An A4NN-0J hoist mucks all the ore broken in the stope, spreads the fill that is brought in, and handles timber and supplies that are passed up through the raises.

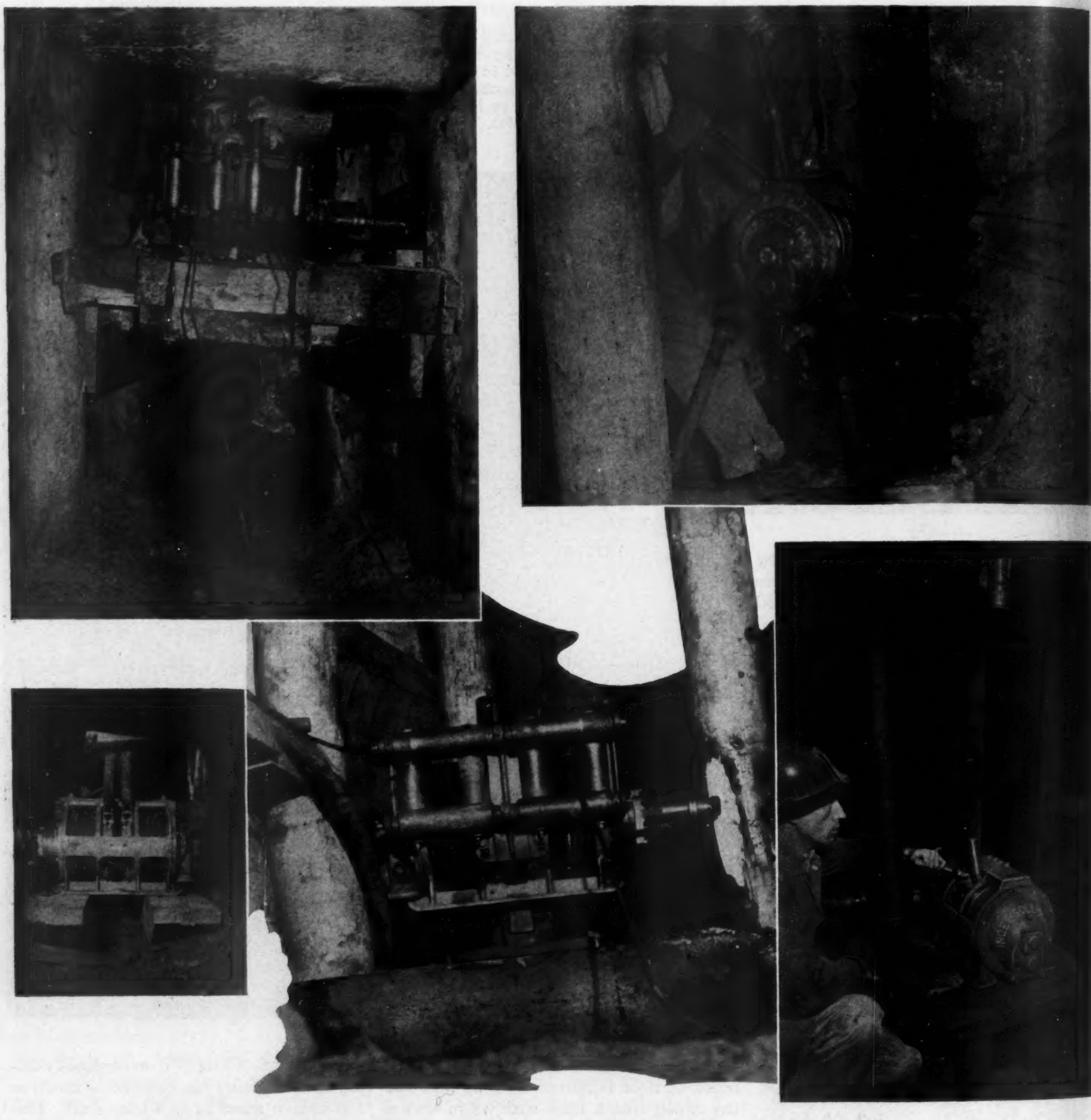
In a stope 6 feet wide, a scraperman, a timberman, and a miner carry out the various operations that constitute the working cycle. The scraperman cleans up the round of broken ore, which runs between 18 and 25 tons, in from one to two hours. He then helps the timberman "rustle" timber and erect the set. The miner does everything pertaining to the actual breaking of ore. It is essential to lace or lag carefully the hanging wall of the vein, since it is heavy and tends to slab off. The ground has to be very closely timbered.

During the filling of a worked-out stoping area the hoist has handled as much as 150 tons of waste in an 8-hour shift. This is extremely important, for once a section 100 feet long and 20 to 25 feet high is cleaned out and open, it should not be left unsupported very long. Small scraper hoists are doing a good job in this class of work, for they facilitate muck removal in the low sets. Furthermore, their use permits the men to mine their block of ore more quickly and to a greater height than when hand-mucking was practiced. Although the foregoing is generally referred to as stringer-set stoping, the method is similar in many respects to that of the conventional square set.

Small hoists also have proved of great value in this mine in station cutting. A hoist of this type is small enough to be placed in the shaft proper, where it is out of the way. So located, it can move all the broken rock directly to a sinking

MUCKER'S DELIGHT

Inspired by the light weight and easy portability of the new, small slushing hoists, a Butte mining technician, who is also a cartoonist, made this drawing. It is a bit exaggerated, of course, but there is no denying that scraper-loading takes a lot of the backache out of mining. For that reason American miners prefer it to the "muck stick."



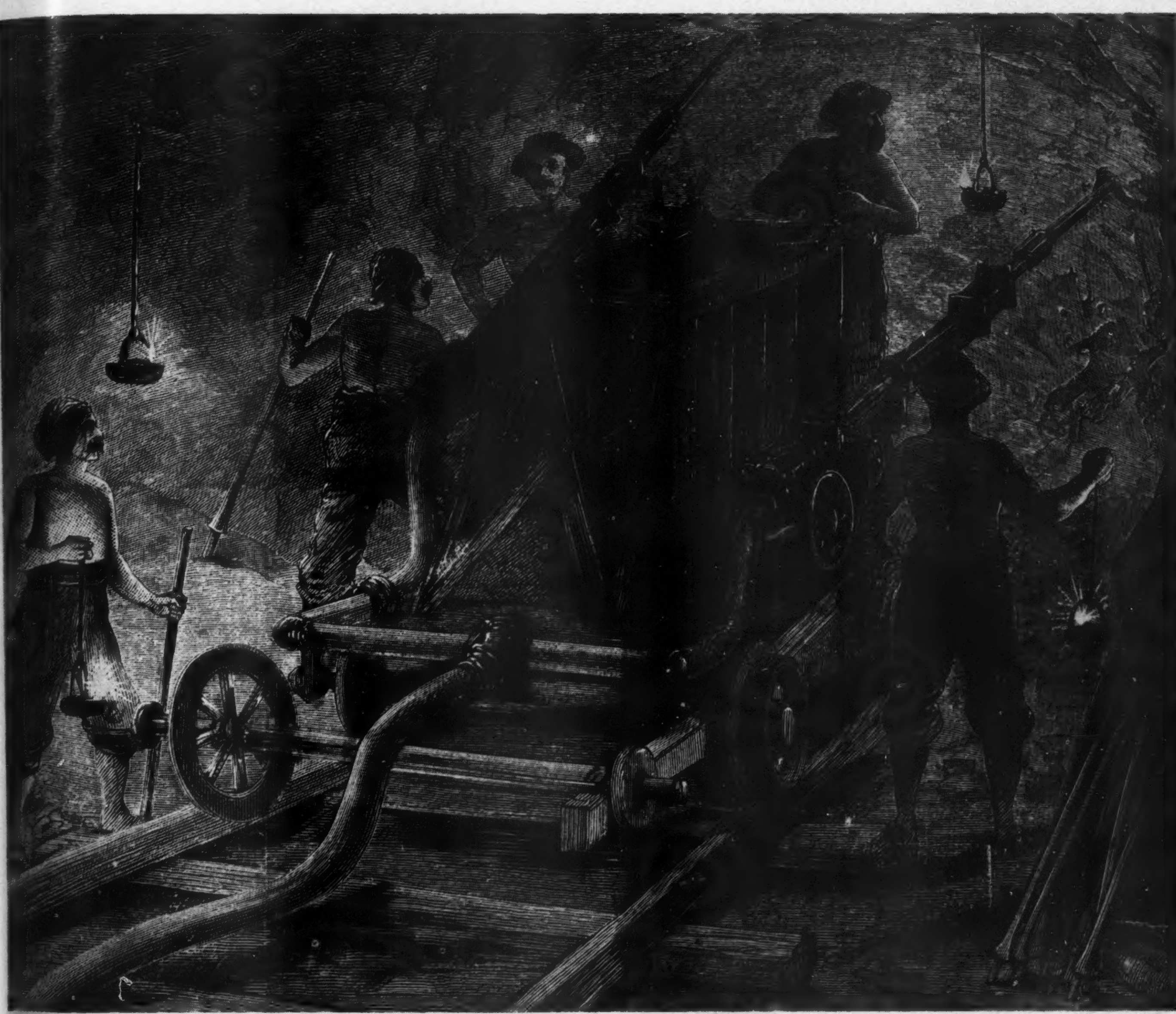
METHODS OF MOUNTING

These small hoists can be mounted in many different ways, a few of which are shown here. The one at the bottom-center is a turntable mounting that permits swinging the hoist to any desired angle or quickly reversing its direction of pull.

bucket in the shaft. For example, one hoist, mounted on a wall plate, pulled a 28-inch scraper the full length of the station—which at that time was between 45 and 50 feet long, 16 feet wide, and 10 feet high. As the rock was slabbed from a small heading the scraper delivered it to a flared slide directly in front of the center compartment of the shaft so that the muck could drop right into the 1-ton sinking bucket. This particular station was 110 feet below the lowest working level. With the aid of the small hoist and the scraper, the operator has handled 50 such bucketloads in an 8-hour shift.

From the foregoing it will be seen that the modern scraper hoist is indeed an adaptable machine, and that a hoist-scraper hook-up lends itself to a wide variety of uses. Although the basic idea is not a new one, it is only of late years that the advantages of these hook-ups have been fully appreciated. The A4NN-0J hoist that is used in the mines mentioned was designed expressly for scraping jobs in thin, narrow veins or stopes, irregular veins, and crosscuts. As has frequently been demonstrated, a unit of this type will soon pay for itself by saving time and money in waste-spreading operations, development work, etc.

With regard to the hoist-scraper arrangement, certain definite conclusions have been reached. One of the most important is that a single operator can handle enough ore per shift to fill a railroad gondola car—assuming, of course, that the scraper haulage distance ranges from 50 to 75 feet. One mucker has summed it up as follows: "It used to be that the motor swamper had his neck stuck up the chute half the time yelling for more muck. The miner could cover me up, and the shifter was always howling, 'Rock in the box!' Now I can yell, 'Come on, pull the chute'; and I can tell the miner to mow 'er down. I haven't seen the shifter in two days—he's rustlin' empties!"



DRILL CARRIAGE

This sketch by a "Harper's Weekly" artist shows what was evidently the first apparatus ever devised for multiple-drill mounting. The mechanism was probably used in one of the smaller galleries, for carriages with as many as ten drills were employed in some sections of the work. By turning the hand wheel near the back end of each tool it was apparently moved forward as the hole grew deeper. We are told that water was introduced into the holes while drilling was in progress, although the drawing shows no water connection. Note the use of oil lamps.

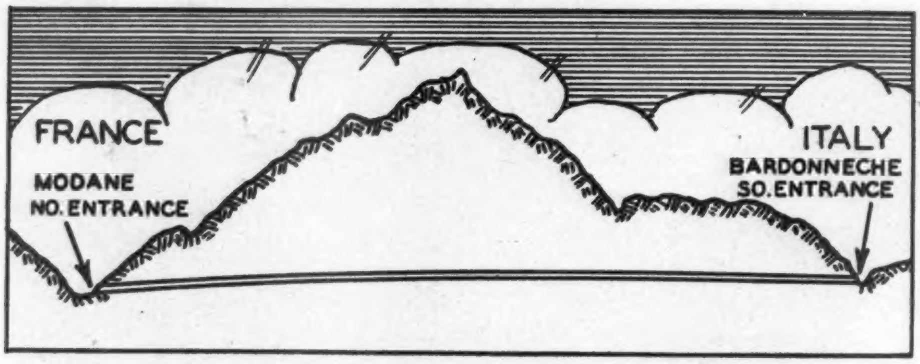
Mont Cenis Tunnel Doomed Hand Drilling

C. H. Vivian

THE Mont Cenis Tunnel, which carries railroad trains through the Graian Alps between southeastern France and northwestern Italy, is historically important in the field of engineering construction for several reasons. It served as a cradle for the development of both the rock drill and the air compressor, and it was probably also the first large job on which dynamite was used.

Considering that the Mont Cenis Tunnel is 7.98 miles long and of large cross section, and that the most advanced tunneling technique known when it was started consisted of drilling by hand and blasting with black powder, it must be conceded that the project was an exceedingly bold and ambitious one. It has been estimated that, save for the fortuitous advent of the rock drill, some 40 years would have been required to complete the bore, if, indeed, its builders would not have had to give up the effort long before the expiration of that time. As it was, work was conducted for more than thirteen years before the two headings met, mechanical drills having been introduced during the fifth year.

The Mont Cenis Tunnel was the first of a series of railroad passages through the Alps. Political and military upheavals delayed its construction for some years, and it was finally undertaken during the reign of King Victor Emanuel II, the first king of Italy. It was made possible by the efforts of the king's chief advisor, Count Cavour, who succeeded in bringing the railway lines on opposite sides of the Alps—both in Savoy, France, and Piedmont, Italy—under one management. The tunnel, together with its approaches, connects Modane, France, with Bardonneche, Italy. It obtained its name from the nearby mountain height and also from Mont Cenis Pass which, at eleva-



PROFILE OF TUNNEL

The Mont Cenis Tunnel was the first connecting link between the railway systems of France and Italy. The first trains ran through it in 1871. The tunnel ascends towards the Italian end on a grade of 2½ per cent. More than thirteen years were required to do the excavating.

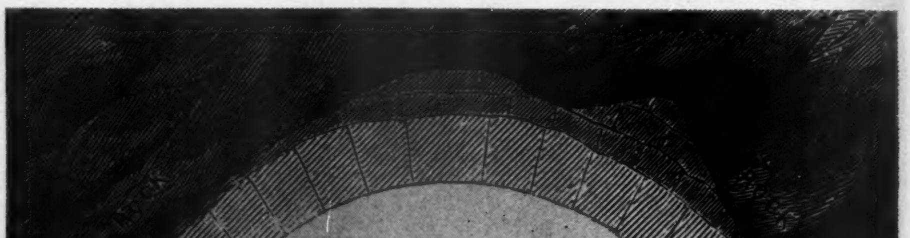
tion 6,893, forms the lowest natural crossing in that part of the range. The pass lies between the Cottian and Graian Alps. Napoleon built a carriage road over it, and a light railroad was likewise constructed there in 1868 but was dismantled upon completion of the tunnel. The latter does not run beneath the pass; it is some 17 miles to the southwest of it. It penetrates the Col de Frejus and formerly was often called the Frejus Tunnel, as well as the Grand Tunnel. At its highest point it is 4,249 feet above sea level.

The tunnel is 42,157 feet long and of horseshoe-shaped cross section, being 26 feet 3 inches wide and 24 feet 7 inches high. Except for a stretch of 900 feet, where the rock was very sound, it is lined with brick and masonry. Work was started on August 18, 1857, and the two headings met on Christmas Day in 1870. It is recorded that the cost was $15,000,000, or $356 a linear foot. This is not excessive in view of the cost of some modern railroad tunnels where severe conditions were met; but if wages at that time had been comparable to those paid in recent years, the expenditures would, doubtless, have been much greater.

During the period in which hand drilling and black powder were depended upon, progress is reported to have been about 9 inches daily at each of the two headings. This means that only 2,190 feet of tunnel was excavated during the first four years. The remainder, or 39,967 feet, was driven in approximately 9⅓ years, or at an average rate of 11½ feet a day at the two headings. It is evident, therefore, that the use of power drills multiplied the rate of advance almost eight times. According to Peele's *Compressed Air Plant*, the footage at each heading was increased to 4.75 a day soon after machine drills were introduced, and later, when dynamite became available for blasting (1863), progress was further speeded up to 6 feet. This average was maintained for six years.

Accounts differ as to who devised the rock drills that were employed, but it is certain that Sommeiller and two associates were responsible for making them work. J. J. Couch and J. W. Fowle had both developed mechanical drills in America prior to that time, but neither type was suitable for service in tunnels because they were operated with steam. Peele states that Collodan, the physicist, proposed using compressed air at Mont Cenis in 1852, which was five years before the project was started. An account of the work that appeared in *Harper's Weekly* for March 20, 1869, reports that "An English engineer, Mr. Bartlett, had patented, in 1855, a machine for perforating rock by a pointed iron bar, which was to be darted forth out of a tube charged, like an air-gun, with condensed air." It was related, however, that Bartlett's apparatus, like the Couch and Fowle drills, "was not suitable for a long tunnel, as it required a steam engine to compress the air. No such engine, with its furnace or fire, could be kept at work in the far interior of the tunnel, miles away from the outer atmosphere."

Apparently no one had thought of compressing the air outside of and conveying it into the bore, or perhaps that was not considered feasible. In the end, however, this was done, and Sommeiller and his assistants are credited with having made it possible. All these men must have been very young, for they were students at the time at the University of Turin and intimate friends. Sommeiller was a native of the Vallee de Sixt, in Savoy, while the other members of the trio—Grattoni and Grandis—hailed from Piedmont, on the



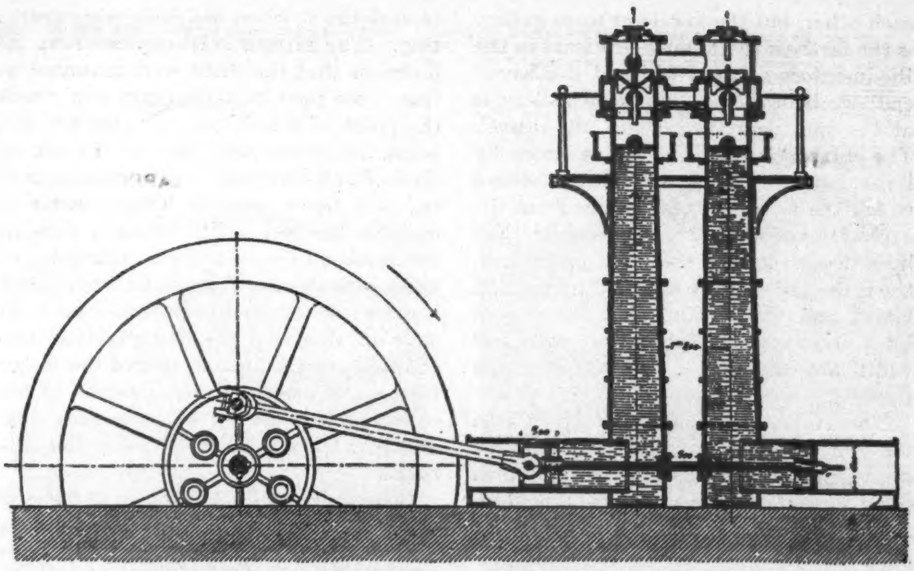
CROSS SECTION OF TUNNEL

This drawing from the March 20, 1869, issue of "Harper's Weekly" conveys an idea of the tremendous task it was to line the bore, especially as cavities caused by overbreak of the rock had to be neatly filled. The section constructed from the French end was cased with stone, while brick was used at the Italian end.

Italian side of the mountains. According to the article in *Harper's Weekly* previously referred to, the group became acquainted with Bartlett's idea for a compressed-air drill in 1854 and visualized a water-driven machine to compress the air.

To quote again, "The design of these young engineers was promptly recognized and assisted by a truly liberal government. A bill was immediately passed by the Chamber of Deputies at Turin, authorizing the Ministry to make experiments under the direction of Messrs. Sommeiller, Grandis, and Grattoni, at the public cost; and M. Sommeiller was provided with a seat in Parliament that he might explain his plans for himself. Machinery was ordered from Belgium, manufactured by Messrs. Cockerell, near Liege, and set up at a place in the vicinity of San Pier d'Arena, near Genoa, where the double process of converting water power into reserved air power, and of applying the air power, conveyed in long tubes, to the perforation of hard rock, was thoroughly tried with every possible variation. The result will be the conquest of the Alps, in the first instance, and subsequently, we doubt not, a future revolution in the system of underground mining, which will be conducted hereafter with a much higher degree of rapidity, economy, and safety than it has yet attained." That the prophecy advanced in the final sentence has been fulfilled is now well known. The rock drill and air compressor have, as much as any two inventions, made this the age of metals. They have also made practicable the speedy and economic construction of highways and tunnels, and dams and hydroelectric projects, and done much else to advance civilization in general.

An accompanying drawing, which is reproduced from *Appletons' Cyclopaedia of Applied Mechanics*, published in 1880, shows a cross section of what was described as "the improved Sommeiller compressor used in the tunneling of Mont Cenis." The use of the word "improved" implies that changes had been made in the original design even before the tunnel was completed. The machine was driven by water power, and the air was compressed by columns of water rising in two vertical cylinders with closed tops. The water was forced into these cylinders by the reciprocal action of pistons working in horizontal cylinders. As the water rose in one column, it descended in the other. The top of each compression cylinder was fitted with five valves. Four of these were circular leather leaves with a metallic backing. As the water level dropped, two of them opened to permit drawing in atmospheric air from an enveloping iron cylinder. The other two opened into a water box and admitted water to replace that entrained by the compressed air or lost through leakage. In addition, there was an air-discharge valve of bronze and conical in shape.



SOMMEILLER'S COMPRESSOR

Longitudinal section through a hydraulic-piston compressor that was designed to supply air for operating the rock drills used in boring the Mont Cenis Tunnel. The machine was driven by a water wheel, and the air was compressed by water columns rising alternately in the two vertical cylinders.

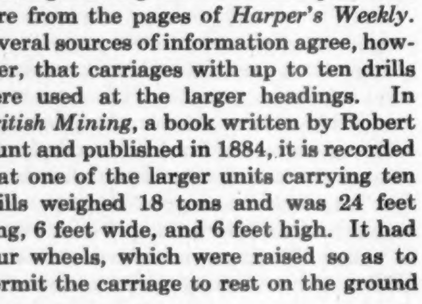
According to the book from which the drawing was obtained, the air was compressed to seven atmospheres, or about 90 pounds, gauge pressure. The hydraulic wheel that drove the unit was 216 inches in diameter and normally turned at 8 rpm., at which speed the machine delivered 476 cfm. of air. The pistons had a diameter of 23.4 inches and moved through a stroke of 58.5 inches. The air leaving the compressor had a temperature of 104°F. One of these units was stationed at each portal of the tunnel, and the air was used to ventilate the workings as well as to operate the rock drills. Large storage facilities were provided, one source of information stating that there were fourteen receivers with an aggregate capacity of 28,000 cubic feet. In the *Harper's Weekly* account of the undertaking we read that "The condensed air, with the density and elastic force of seven atmospheres, is kept in huge reservoirs, like steam boilers, always ready for use; and they have been left full-charged during twenty-four days without losing more than a five-thousandth part of the stored-up power. An iron conduit tube, or series of tubes, rather less than a foot in diameter, joined together by strong rivets, is laid upon tiles along the tops of a row of square pillars of masonry going into the tunnel. This continuous tube of indefinite length conveys the pneumatic force from Forneaux or Bardonneche, where the air is condensed, to the most advanced part of the works, in the very bowels of the mountain, where the rock is stabbed, torn, and blasted by the daring ingenuity of man."

The same source describes one of the rock drills as a rather complex piece of machinery "which has a two-fold action—namely, that of a piston in a cylinder for propelling, somewhat like a popgun, the boring tool against the rock; and, secondly, a rotary action, which at the same time works the valve of the propelling cylinder —an ingenious combination—and gives a twist to the boring tool when it enters the rock at each successive stroke. The boring tool, drill, or needle, or whatever it be called, is simply an iron bar with a point 2 inches wide, shaped like that of a chisel or adze, and very frequently sharpened, hundreds and thousands of these tools being soon worn out. The strokes of the tools smiting the rock make a noise which resembles the report of muskets. It is calculated that to bore eight holes of the requisite depth, which is 3 to 4 feet, in a hard piece of rock, the piston rod must give 57,600 strokes, and the rotary cylinder make an equal number of revolutions. The machinery therefore often gets out of repair, and on this account, as well as for the sharpening of the drills, the workshops at each end of the tunnel are busily employed."

The customary modern procedure in the case of large tunnel sections—that of driving an advance heading of relatively small area and then enlarging it—was followed at Mont Cenis. Standard works on tunnel-driving state that a top heading was used and that no bore was driven with a bottom heading until the Alberg, which was constructed from 1880 to 1883. However, the article in *Harper's Weekly*, which was apparently based on the personal observations of the writer, does not verify these statements. To quote again: "The width and height of the intended excavation, including the space to be filled with masonry at the roof and sides, are so considerable that it has to be carried forward in three drifts or galleries, at different elevations. These do not keep pace with

each other, but the lowest or main gallery is the farthest in advance—at least in the Piedmontese section; while at the Savoy end, we believe, the advanced gallery is at the top, near the roof of the tunnel. The entrance to each gallery is closed by large doors, turning on pivots, behind which the workmen take refuge from the explosion and shower of stones when they blast the rock. As the work progresses, the three galleries are enlarged by manual labor, and thrown into one broad and lofty excavation, in which the walls and vault are then built to complete the tunnel."

The advance headings were driven with the aid of drill carriages. It is thus established that these devices, which some persons consider to be of modern origin, were used from the time air-operated rock drills were introduced. The carriage, or frame, as it was originally called, varied in size according to the cross section of the heading. A carriage mounting two drills—one on each side—was employed in the smallest galleries, and a drawing showing one of them is reproduced here from the pages of *Harper's Weekly*. Several sources of information agree, however, that carriages with up to ten drills were used at the larger headings. In *British Mining*, a book written by Robert Hunt and published in 1884, it is recorded that one of the larger units carrying ten drills weighed 18 tons and was 24 feet long, 6 feet wide, and 6 feet high. It had four wheels, which were raised so as to permit the carriage to rest on the ground



A DRILL ROUND

This was perhaps the first round to be drilled and blasted in a tunnel driven with air-operated rock drills and dynamite. The sketch shows the arrangement of the holes drilled in the heading of one of the three galleries that were advanced separately and then interconnected to form the full tunnel section. The pattern is known as the circular-cut system. The center hole and the eight grouped around it were fired first, taking out a central block of rock and leaving a cavity for the other holes to break to. The holes varied in depth from 30 to 48 inches. They were started with bits of 1¾-inch diameter and finished with 1⅜-inch size. The drawing originally appeared in Hunt's "British Mining."

to stabilize it when the drills were operating. The *Harper's Weekly* account informs us that the drills were mounted so that "the men in attendance can direct the point of a tool not only straight forward, but to the right hand or the left, or upward or downward. A pipe accompanying each borer pours in a little water to moisten the rock. The whole apparatus communicates by a large flexible tube, or hose, with the fixed iron tube from which it draws its supply of condensed air." It thus appears that the first practical mechanical rock drills had two of the major features of modern drills: rotation of the steel, and injection of water to allay dust and perhaps also to wash away the cuttings.

Concerning the effectiveness of the drill carriages, Hunt wrote: "When rock boring machines were first introduced, the miners insisted on employing them as mere substitutes for the borer and mallet, and upon placing the holes so as to 'take advantage' of the ground. The result, however, proved unsatisfactory. Not only was the time required to get a position for the machine, to fix, and to remove it, excessive, but the work accomplished was not in proportion to the cost. The engineers of the Mont Cenis Tunnel were the first to recognize the fact that, if the power machines were to be employed for drilling shot holes, the hand method of working the ground must be discarded. A given number—ten machines—were therefore mounted on a carriage in such a manner that each would perforate a given area of the surface. The natural rupturing lines of the rock were disregarded; deep shot holes were drilled, charged, and blasted, and in this way a definite length of ground was removed."

The rock formation penetrated by the tunnel includes mica schist, quartzite, limestone, and clay slate. Two construction-railway lines of 39½-inch gauge were laid in the bore. "Along these," reported the *Harper's Weekly* correspondent, "trains of wagons, drawn by horses, bring in the implements or materials for the work, and carry out the fragments of stone and rubbish from the excavation, to be thrown into a heap outside." The workings were lighted with coal gas, which was piped underground, and oil lamps were used in the advance headings. Blasts were fired by "laying a train or lighting a slow match," and the tunnelers retired behind the closed doors previously mentioned until the powder did its work. Following that, a jet of compressed air was turned on to clear the heading of smoke. "The trucks or wagons," to continue quoting, "are then brought up to remove the broken stone; the road is cleared and the machine comes again to make a new attack, which is usually aimed rather to one side of the breach already opened, so that the whole width of the gallery is soon cleared. Sometimes, we believe, the alternate operations of boring and blasting can be performed three or four times a day.

"The heat in the tunnel is felt to be oppressive, which may be due to the discharge of excessive caloric from the condensed air. Visitors, before entering, change their clothes for a blouse and pair of linen trousers; the workmen are often naked to the waist. But the atmosphere is not foul or closer than in an ordinary mine. The work never ceases, day or night, the men being divided into three gangs or 'shifts' who labor each eight hours at a time. They are sturdy, thick-set Piedmontese, indefatigable in their sober good humor."

The tunnel ascends from the French side to the Italian side on a grade of 2½ per cent, and for many years after it was opened to traffic considerable difficulty was experienced with smoke from the locomotives pulling trains up the slope. Reference to this is made in the 1901 report of the Smithsonian Institution. It was stated that the custodians traveled the tunnel in pairs so that if one were overcome the other might summon aid. Spaced at intervals of a kilometer (0.62 mile) were refuges or *grand chambres*, provided with compressed air, a telephone, water, medical supplies, a thermometer, and a barometer. When the men felt themselves in danger of being overcome, they retired to one of these stations and turned on the compressed air. The temperature in the tunnel was reported to remain at 68°F. throughout the year.

From what has been written, it will be noted that the Mont Cenis Tunnel was a proving ground for the first power-driven rock drills and compressors. The work attracted world-wide attention and stimulated the efforts of inventors, with the result that improved drills and compressors soon made their appearance. The Hoosac Tunnel in the United States was started with hand drills in 1858, and in 1866 power drills and compressors designed by Charles Burleigh were adopted and utilized until the work was completed in 1874. Between 1872 and 1875 the Lehigh Valley Railroad constructed the Musconetcong Tunnel in New Jersey in order to extend its line from Easton, Pa., to Jersey City, N.J. This bore marked the first use of drills produced by the Ingersoll Rock Drill Company. Twenty-six of those tools were employed on that job. In 1874, Burleigh drills were introduced in the Sutro Tunnel that was driven to drain the mines on the Comstock Lode in Nevada. The 9.8-mile St. Gotthard through the Alps was built from 1872 to 1882, utilizing Ferroux and McKean drills. Although the superiority of machine over hand drilling was clearly demonstrated on all these undertakings, the method was not generally adopted by the mining industry for a good many years. Contemporary writers attribute this to opposition on the part of the miners and also to the great weight and clumsy design of the drills that were then available.

Portrait of an Old Timer

Laura B. Bourret

SCATTERED about Colorado are a few miners, still vigorous in their sixties, who saw and took an active part in the development of Cripple Creek and the other boom districts of the state and whose anecdotes recreate those gilded days for their listeners. These oldsters are still actively engaged in mining and, for the most part, scorn the younger men and the engineers. They know underground work "inside out" and, whatever the task, they do it thoroughly. They also have a pretty shrewd understanding of the financial aspects of mining, and their knowledge of human nature serves them well: neither their employers nor their associates can escape the canny evaluation of having their "measure taken" by them.

Such a man is A.J. Brechbuelle of Idaho Springs, whom everyone calls "Blackie." Now 68, he is remarkably well-preserved and physically and mentally sound. He is still busy earning a livelihood, though his friends say he can afford to retire. Until recently he held a regular job with the Clear Creek Consolidated Mining Company, operating small leases on the side with the help of one or two men.* He states proudly that he can work all day, "night club" all night, and go to work the following day and hold up his end with the "best of 'em"; and one gathers that these "best," in his opinion, are none too good. He modestly implies that he is quite sought after by his lady friends, commenting in response to a teasing query, "Why should I get a new car; they'll ride with me in a wheelbarrow."

Blackie was in Cripple Creek when it was at its height, and one does not doubt him when he says, "Believe me, I've seen plenty!" He tells of one Christmas there when a Salvation Army pot was set up at a busy corner. By afternoon it had been filled with gold coins by passing miners and promoters; those who came by later just threw their donations on the ground at the base of the tripod which, by night, was literally obscured by a pyramid of gold. Such an incident reflects the lavish spending and conscience-money giving of a community of easy-come fortunes.

Blackie relates with gusto the story of how he made and lost a fortune without ever seeing any appreciable amount of it. He was, at the time, a brakeman on the Cripple Creek Short Line Railroad. One night, while off his run, he met a friend named Reilly at a bar in Cripple Creek. Reilly told him of a mining lease, the War Eagle, which he held, and of his need for

"TUFFY"

Blackie's foster grandson and also his pride and joy, arrayed and implemented like a miner.

$200 to develop it. Blackie then and there gave him $300 outright, without a scratch of a pen or a look at the property, and promptly forgot about it.

Three months passed before Blackie returned to Cripple Creek and the same bar. There he encountered Reilly again. The latter slapped him on the back, demanded to know where he had been, explaining excitedly that he had been looking for him "high and low" to give him his half of the $180,000 that he had taken out of the mine since Blackie had supplied financial aid. Reilly was confident that they would each realize a million from the property, and urged Blackie to come to Denver with him for a celebration. But Blackie preferred to remain in Cripple Creek, and says he spent $2,000 there while Reilly celebrated to the tune of $30,000 in Denver. Blackie swears that the records at the Brown Palace Hotel for 1906 will show that Reilly gave a bellhop $1,000 to purchase enough champagne for him to take a bath in. One is inclined to hope, though, that Reilly, upon the arrival of so much champagne, reconsidered and used it to better advantage.

After Reilly's spree in Denver, and with the profits taken from the War Eagle, he and Blackie spent two years working another mine, which they believed to be even richer than the former. This property, the Six Points, did turn out to be richer, but, alas, they were not the ones to prove it. They not only put all their joint fortune into its development but also went

A. J. BRECHBUELLE

into debt to the tune of $15,000. Becoming discouraged, they approached a leading citizen of the town; and he bought the property for the amount of their debt, thus putting them in the clear, but leaving them exactly where they had started.

The new owner employed an engineer to develop the Six Points Mine, and the latter promptly discovered a narrow vein that the two had overlooked because it had become mudded over in the crosscut. The vein yielded an ultimate profit that is said to have reached the not unsubstantial sum of $2,000,000, and Blackie and Reilly had literally passed it by! We asked Blackie if he felt bad when he learned that he had let a fortune slip through his grasp; but, with true mining philosophy, his reply was, "No, I always figured if I missed it one place I'd hit it somewheres else." And at 68, it is apparent that he is still unhurriedly confident of doing just that.

Blackie has peculiar ideas of justice, and has never considered our present-day court system to be of any value: he doggedly advocates personal settlement of all wrongs and disagreements. "If a man wrongs you, you settle it," is his terse summary of justice. In the early days this was the only law, he asserts, and he is still convinced that it is the best way. He thoroughly approves of letting the law of the survival of the fittest shape the destiny of man, and heartily disapproves of Government aid or provision for the unemployed, claiming that there is work for everyone but that modern man is afraid of real toil and long hours. He vows that he would not turn over to the authorities any criminal who has done him no wrong, and tells a colorful tale to prove it.

Many years ago, while in Cripple Creek, he received a letter from a La Junta, Colo., banker, asking him to come down for a talk with him and inclosing a check to cover the expense of the trip.

*Editor's Note: Since this article was written, Mr. Brechbuelle has left Idaho Springs, probably temporarily, to engage in mining in the vicinity of Anthony, which is located on the state line between New Mexico and Texas.

Thos. J. Barbre Photo

CRIPPLE CREEK

Famous gold-mining camp where Blackie spent a number of years and almost came out with a fortune. Once a city of 10,000 persons, Cripple Creek was denuded during a boom in building materials following the first World War.

Says Blackie, "I figured it was somethin' important because he sent the money; so I went right away." On his arrival, the banker showed him a vial of gold and asked him what he thought of it. Blackie thought it looked good, and told him so. Whereupon the banker related that a man with a long, red beard had brought it in and wanted him to invest in a placer mine in the Utah desert, from whence the sample came. Would Blackie be willing to locate the place, and look it over for him? The trip entailed crossing the desert for three days on horseback, and carrying enough water for two of the three days. Blackie agreed to go, and the banker gave him a map of the route, instructing him not to drink of the water in the first stream, which would be poisonous: he must wait till he reached the second one which would be sweet water. So, armed with this necessary information, Blackie obtained two horses and enough water for himself and the animals for two days, and set out.

At the end of two days he realized, by locating himself on his map, that he was only two-thirds of the way to the pure stream, and he knew that there was going to be a day of agony for himself and the horses on that parched wasteland: and so it proved to be. When he came to the poisonous water, he was sorely tempted to chance it, but forced himself over a 7-mile ridge to the sweet water. Reaching it, he threw himself off his horse, drinking long and deep of very life itself. Then he lay down and slept. When he awoke, many hours later, he found the horses with noses still immersed in the cool waters.

On the fourth evening he reached his destination and found the red-bearded man who would have been hard to miss anywhere, his beard being waist-length and carrot-red. Next day, Blackie began his investigation of the alleged placer. He took up a pan of gravel and washed the dirt in the stream diligently, but could see no signs of gold, though he kept panning steadily, every once in a while glacing at his companion who had a great quid of tobacco in his mouth and was chewing mightily. Gradually, but without registering surprise, Blackie became aware of a curious thing: the red-beard would, at intervals, spit into his pan of dirt, wash it, and presently take gold from his pan. When the man came over to Blackie, looking over his shoulder to inquire how he was getting along, he spat into Blackie's pan. This confirmed the latter's suspicions for this time his dirt also washed gold. Here, indeed was an ingenious method of salting a placer mine, but it was not subtle enough to fool Blackie. "I never let on I'd caught on," recounted Blackie, "and I stayed around there three days, making out I was greatly interested. Then I told him I'd move on and have a look at the country before going back."

So Blackie set out again, this time in another direction. After riding all day through the desert he sighted, in the distance, what was unmistakably a ranch, a surprising find in such a wilderness, and he decided to make for it and ask for a night's shelter. On his arrival, Blackie sensed something strange in the presence of eight very tough-looking hombres, but they made him welcome and shared their food with him. One in particular aroused his curiosity because of a peculiar knife scar that extended in a livid line from the corner of one eye down the side of his face and around his chin to the corner of his mouth.

The men were hospitable, though noncommittal, and Blackie stayed three days, resting and playing cards. No explanations were forthcoming as to why they were living as they were, nor did he probe them for any, of course. On the morning of his departure, the scarred-faced fellow rode out with him to show him a trail that would lead him back to civilization. Across jagged country, bare and seared, along sheer cliffs, the two traveled. Finally, Blackie's companion reigned in his horse, pointed out the route to Blackie, and departed, first wishing him good luck and tersely commanding him not to look back.

In two days Blackie was back in La Junta. He told the banker briefly what he had discovered at the placer and also mentioned his stay at the ranch. Blackie's individualistic interpretation of justice and his unswerving convictions are clearly evidenced in the denouement of this experience. A few weeks after his return to Cripple Creek he received a letter from the banker telling him that the eight men who had been his hosts were desperate criminals—the McCarty gang—wanted by the State of Utah for train and bank robberies and murders. No one had ever been able to locate their hideout, and if Blackie would lead a posse into their stronghold he could claim the $500 reward posted for their capture. At this point in

Thos. J. Barbre Photos

IDAHO SPRINGS

The town that Blackie calls home, although he wanders wherever mining beckons. At present he is down on the border between New Mexico and Texas. The monument, a stream-washed boulder bearing a bronze plaque, was erected in 1909 to mark the site of the discovery of gold in 1859 by George Jackson, a Georgia miner who joined the gold rush in the "Pike's-Peak-or-Bust" era. The bottom picture shows the surface buildings of the Argo Mill. They are located at the portal of the 6-mile Argo Tunnel that was driven to drain a number of mines and to serve as a means of transportation for their ore. The other end of the tunnel opens via a shaft on to the mining town of Black Hawk.

his narrative, Blackie's dark eyes snapped, his fist came down hard on the arm of his chair, and he fairly shouted, "Do you think for a minute I'd do that, or take money for such a thing?" Then, slowly, he explained with great emphasis, "That was those men's way of earning a living: let the people whom they have harmed settle with them, not the state, and not me that they fed and sheltered!" Subsequently, the governor of Utah urged his aid in the matter. Blackie still has his letter, which swayed his decision not in the least.

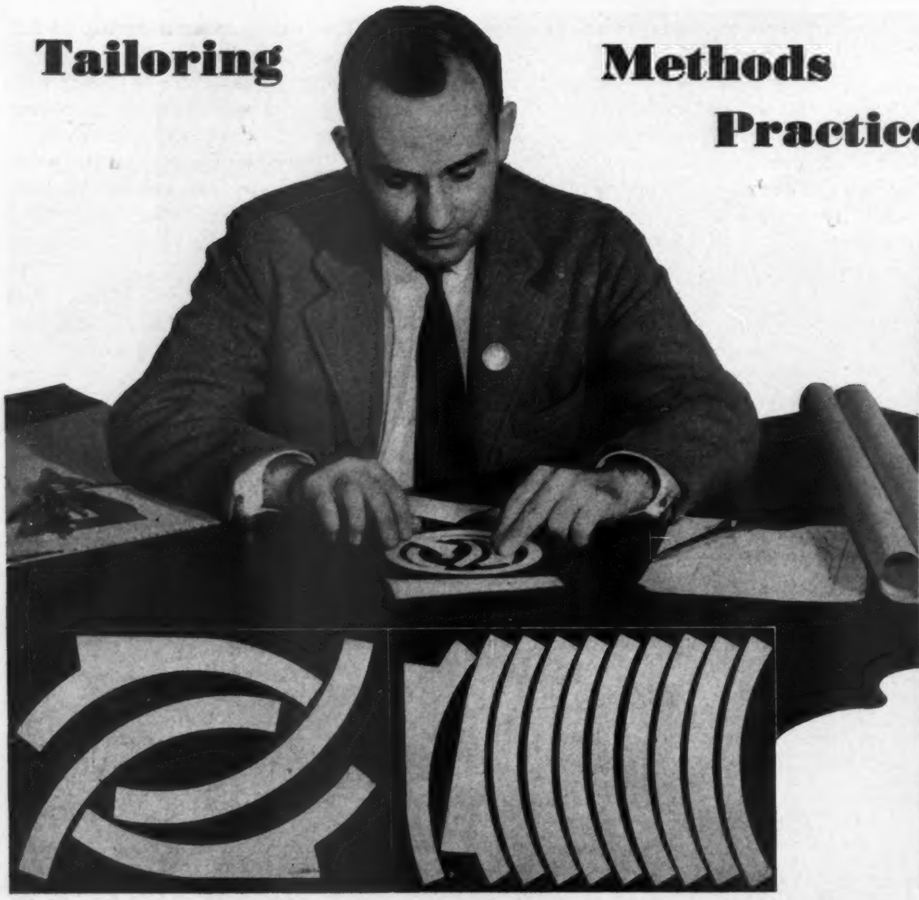
About two years later, Blackie was in a saloon where miners gather and, looking up from his beer, saw the scarred-faced man come in who had lead him out of the hideout. "I said, 'hello, guy, sit down an have a drink,' " Blackie quotes himself. " 'What are you doing these days?' " In low tones the fellow told him he had "busted up" with the gang soon after Blackie left and had been working in a mine ever since. "The day I took you out," he informed him, "I had orders from the others to shoot you, anyway not to let you leave alive, but I couldn't do it, and that started my split-up with the gang." As he finished his tale, Blackie turned to me with the query, "Well, what would you have done? Would you have turned those men in and taken that money after they had been kind to you?"

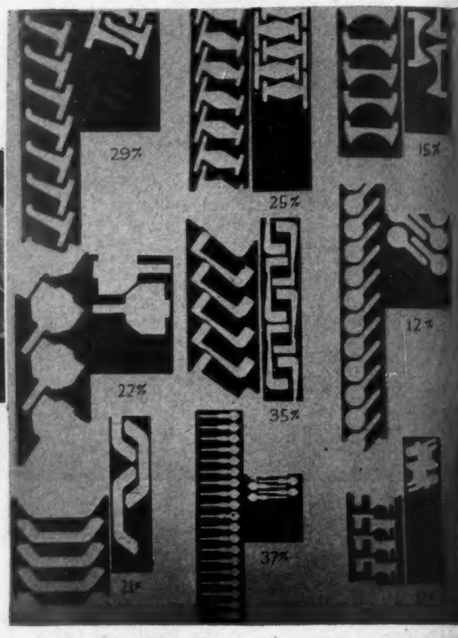
"But, Blackie," I replied, "they weren't really kind to you, they intended that you should be killed. Why should you have protected them, especially since their existence at large was a menace to the lives and property of countless others?" "No," says Blackie, shaking his head ruminatively, "I did right the way I see it. They didn't do me any harm, and as for the other people, let them take care of themselves."

Blackie abhors softness in the miners and other laborers of today, believing in the hard way of life and that the individual should be able to take it. And there is no room for doubt that he has withstood the tests which he prescribes for others. But with all his mental and physical hardness, his armor has an Achilles spot, his devotion to his small foster grandson whom he calls "Tuffy." One night Blackie dropped in to see us for a few moments to discuss a lease, and parked his ancient Chevrolet coupe in our yard. In a minute I heard a horn begin to blow loudly and peremptorily, and judging that it issued from Blackie's car, I was at a loss to guess who might be summoning Blackie in such a high-handed fashion. Blackie paid no attention for a few moments, then rose to go, explaining delightedly. "Little Tuffy's out in the car, and he's waitin' for me to take him to town for an ice-cream cone." Then we knew who rules the Brechbuelle household, despite all Blackie's self-styled hardness.

Tailoring Methods Practiced in Industry

A. M. Hoffmann





EXAMPLES OF MATERIALS CONSERVATION

At the top is a General Electric layout man with his tools and a set of paper patterns of flat motor parts. His job is to arrange them on a metal plate of a given size so that the pieces can be cut from it with a minimum of scrap. At the right is an exhibit of nine different machine parts showing how they were disposed before and after the paper-pattern method was introduced. The percentages indicate the savings in metal effected in each case. The two layouts at the lower left give a graphic idea of what can be accomplished when designing engineers and layout men co-operate in materials utilization. By reducing the arc lengths of motor segments from 90 to 60°, and by arranging the templates crosswise instead of lengthwise, it was possible to obtain ten instead of four parts from a single plate. As a result of this advantageous nesting, the segments for 72 large motor frames were cut with a 20 per cent saving in metal, or a total of 537,000 pounds of steel in the course of twelve months.

TAILORS and dressmakers, with few exceptions, "stretch a piece of cloth" as far as possible in cutting out a suit or dress, and that is why they can fully appreciate what is being done by those men on the production front whose job it is to get the greatest number of flat parts out of a metal sheet or plate. The necessity of conserving critical materials has compelled manufacturers to resort to similar tactics, and that is why they have turned to "cutting out paper dolls" and "making jigsaw puzzles," as they jokingly refer to layout work.

It has become the practice, especially in the case of complicated parts differing greatly in shape and size, to draw them to scale on paper, to cut them out with a pair of scissors, and to shift them this way and that until they fit so snugly on the sheet from which they are to be cut that only narrow strips of metal will remain as scrap. As a rule, the various pieces belong to one machine, but if closer nesting can be obtained by using parts of more than one product, that is done. Furthermore, if slight changes in the dimensions of a part will effect savings, the engineer responsible for the design is consulted and the changes are made, if practicable. The layout then goes to the shop for guidance in cutting.

As an example of how industry is making ends meet, let us cite what was done by the General Electric Company when slow deliveries of heavy metal plates threatened to delay production of important war matériel. The stock was needed for large circle-shaped pieces that were cut in four sections each. Plates of the same kind but of smaller size were available, and these were found to be adequate simply by dividing the unit into six 60° segments which, having shallower arcs than those of 90°, permitted of closer nesting. As a result of this valuable suggestion from one of the men that make the full layouts, the correctness of which was proved by the paper-pattern method, it was possible not only to meet schedules but to save 537,000 pounds of steel in a year. In addition, by reason of the uniformity of the segments, which enabled them to be placed one under the other with little space in between, they could be cut out at one time—not singly—by a battery of acetylene torches, thus speeding up production.

Sometimes circular parts have to be in a solid piece. These, too, are cut so that little of the square material used is discarded. For example, one stamping job called for a number of ring shapes, and another for parts that looked like a top hat but that were twice as thick as the circular sections. Simply by changing the designs so that both were of the same thickness they could be obtained from one sheet. In short, what was formerly scrap is today cut into eight top-hat pieces—one from each of the corners and four from the center of the ring.

Similar economies are effected in the case of a small T-shaped part stamped out on a punch press. In the days of unlimited material, a strip of metal a little wider than the "T" was fed through the machine, leaving a string of scrap made up of a succession of "T's." By using a slightly wider strip and by reversing and feeding it through the press a second time, double the number of pieces were obtained. Now, however, by means of a double die, the metal passes through the

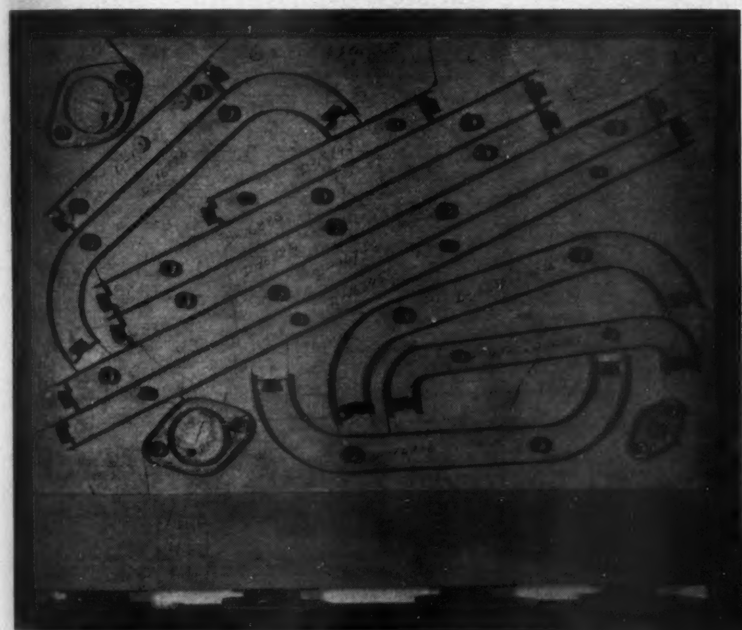
machine only once. All this work comes under the head of "Materials Utilization" and shows what can be accomplished with paper patterns in the hands of trained layout men coöperating with designers.

Another interesting practice of nesting to conserve materials is being followed by Ingersoll-Rand Company in the cutting of gaskets. That concern manufactures a wide range of pumps, compressors, and oil engines, in addition to air-operated rock drills and tools, and requires annually thousands of gaskets of varying shapes and sizes. Many of these are made, oddly enough, in the company's printing plant, where the method of production was developed and where some obsolete printing presses have, as a result, again become very useful pieces of machinery.

Full-sized drawings, with the gaskets disposed so as to waste as little material as possible, are prepared by the engineering department of all but the simple circular form of gaskets. These drawings indicate all holes for studs, dowels, or bolts, and are turned over to the printshop where they serve as patterns for the making of dies. This is done by tacking each one, together with an underlying sheet of carbon paper, on to a ¾-inch plywood block. This is the base of the die on to which the outlines of the drawing are carefully transferred by a pencil or a blunt-nosed instrument and through which the respective holes are next drilled and reamed. Starting at an opening made for the purpose in the block, the design is then followed by a jigsaw.

The cutting part of the die consists of 2- and 3-point (1/36 and 1/24 inch thick) beveled, steel rule which comes in strips 15/16 inch high and which performs numerous services in printing plants. This is inserted, bevel side out, in the sawed slots, and as these are slightly wider than the metal strip the work presents no difficulties. In the case of small sharp curves, it is the practice to use brass rule which is easier to bend than that of steel and will cut nearly as many gaskets as the harder metal. The rule's natural spring is sufficient to hold it in the block—there is no need of brazing or fastening it in any way. This also permits easy removal for renewal when cutting edges becomes worn.

Before the finished die goes on the press, special punches are inserted in the bolt, dowel, or stud holes and the form is locked in a chase—a metal frame—the same as are pages of type ready for printing. The stock used ranges from cork, in 24x36-inch sheets, to asbestos, Vellumoid, and Hydroil, in rolls 36 inches wide, and is from 1/64 to 1/16 inch thick. It is fed to the machine like paper—in sheets that vary with the size of the die—and, as the press closes, is cut either into complete gaskets or parts of gaskets that are dovetailed to assure a tight joint—one of the features of this packing. As many as fifteen pieces are produced in one operation. Changing the work from hand to machine methods has effected great savings not only in time but also in materials—factors that are of vital importance today.



CUTTING GASKETS ON PRINTING PRESSES

The picture directly above shows a 16x25-inch die locked in the chase ready to go on the press. It cuts all the gaskets for a 10½x12 Type S oil engine in one operation. Note the dove-tailing by which the sections are joined. At the top, right, is a job press cutting 1/16-inch-thick gaskets from sheets of asbestos. The work is performed quickly and there is little scrap, as the pile back of the worker indicates. In the view at the right we see a multiple-gasket die locked on the bed of a cylinder press. Through close nesting of the circular and variously shaped gaskets and gasket parts, as many as fifteen are obtained from a 24x26-inch sheet with a minimum of wastage. The operator is holding up a strip to show the clean edges and holes cut by the steel rule and punches.

A Prison Victory Garden

Carey Holbrook

FROM FIELD TO CAN

Tomatoes, of which fifteen acres were harvested last year, are sorted in the shade of large cottonwood trees, cooked under pressure in equipment made largely by prison mechanics, and canned by the trusties. Of the thousands of gallons of vegetables processed last year only four cans were rejected.

THIS is the year of the Victory Garden! Many a vacant lot and cramped back yard is going to rub its eyes this spring and find that food is growing where once the ground was bare. Many a householder and his wife are going to wake up some morning to find blisters on hands that once were soft and white. Americans are going to raise a lot of extra food this year to help win a fight.

Down along the Rio Grande in New Mexico, a Victory Garden has already come to life. It is quite a little chunk of land, all under irrigation, and suitable for the growing of vegetables, fruits, and grains. There are 1,800 acres in the tract, and they have been under development since 1939. Of course they do not call it a Victory Garden. The correct name for it is the New Mexico Prison Farm, and only about 750 acres are under production. But those broad acres, in addition to furnishing a large share of the food for a prison population that numbers more than 600 people, also give wholesome employment to something like 83 trusties who do all the work in connection with the farm.

The New Mexico Prison Farm does not look much different from any other farm, except that the fields are a little better kept than ordinary fields in its vicinity. The trusties who toil there are picked men, selected by the warden because of their dependability. Included among them are cooks, dairymen, hog raisers, laundrymen, carpenters, mechanics, bookkeepers, and even a barber, who carries on his trade after his daily shift on the farm is over. The men work nine hours a day, and then are free to take whatever recreation they care to on the place. There are no armed guards to watch over them, and only occasionally does a man get the wanderlust and run away. When this happens, he is sent back to the penitentiary at Santa Fe and his time off for good behavior is revoked.

Everyone has heard the story of the cat-and-rat ranch, where the owner introduced a system that made the whole operation self-sustaining. He started out with a pair of cats and a pair of rats, and as they multiplied he fed the rats to the cats, skinned the cats, fed their carcasses to the rats, and sold the hides. The New Mexico Prison Farm works out almost as well.

When the land was bought in 1939 there were no structures on it, and it needed to be leveled, irrigation ditches had to be built and the fields plowed and prepared for planting. This was all done by trusties, using brick made by the prisoners in the penitentiary at Santa Fe. Dormitories were constructed, together with a dining hall, storerooms, canning factory, flour mill, machine shop, grain elevator, auto repair shop, milk houses and dairy, storage bins for grain, and barns, poultry houses, and hog pens. Of course these buildings have cost some real cash, but nothing as compared with the actual value of the improvements.

By the fall of 1942 the trusties had 750 acres under cultivation, and that Victory Garden contained a wide variety of crops. At the proper time, fourteen men went into action in the canning factory, in which pressure-cooking equipment was installed for the processing of fruits and vegetables. All the stuff was packed in gallon cans, as it was intended for use in the penitentiary kitchen at Santa Fe. When the score was counted at the end of the season, the tally read about like this: 3,000 gallons of corn; 8,000 gallons of tomatoes; 2,000 gallons of string beans; 2,000 gallons of peas. That was a fairly good pack, the boys thought. But, to make the inventory complete, they also invoiced for their year's work 2,000 pounds of apple butter, 50 barrels of dill pickles, 25 barrels of sauerkraut, and 175,000 pounds of flour. Pretty good for one Victory Garden! But that is not all the story by any means.

One would naturally suppose that the equipment for a canning factory would run up to a couple of dollars or so. But no, good old John Q. Taxpayer did not have to hand out a lot of his hard-earned money for pressure cookers, steamers, washing vats, automatic peelers, and other utensils. They were made right on the spot by prison mechanics, using scrap iron and steel. The boys might admit that they bought a few items here and there, but those purchases were few and the outlay small.

In order to bring the Victory-Garden story up to 1943 it will be necessary to report that the farm still has 10,000 bushels of grain in its bins. It will sell about 600 turkeys this year and about 500 head of hogs. The trusties are growing their own seed with which to plant a permanent pasture, and have 800 pounds of farm-raised alfalfa seed with which to put in additional acres of that crop.

WINDOWLESS PLANT FEATURES

SPECIAL AIR FILTERS

Photo, Compressed Air Institute

WORKING COMFORT

Each operator engaged in buffing and burring in the windowless plant of the Cleveland Graphite Bronze Company is protected against flying particles by an air filter (above) and a glass shield (left). The latter is wide enough to permit free movement of the hands and to give a clear field of vision.

IN THE windowless, air-conditioned plant of the Cleveland Graphite Bronze Company, contamination of the atmosphere in some of the production departments is prevented by filtering systems that have been designed by the company to meet varying service conditions. There are many women at work in the factory polishing and removing burrs from steel-alloy machine parts, and these are protected from flying particles of pumice and metal by a combination glass shield and filter that is a big improvement over the wearing of masks.

The shield is made of shatterproof glass and is fastened to the top of the work bench at a comfortable angle between the operator's hands and face. At the bottom of the shield is an air duct that extends down through the table and connects with a compact filter underneath it. The unit serves both as an exhauster and a dust collector and is equipped with a motor ranging from 1/2 to 3/4 hp., depending upon requirements.

The pumice-and-metal laden air, under the force of the induced suction, is drawn into the filter in a horizontal plane. There it strikes a vertical member, which causes the larger particles to fall on the bottom of the filter housing, from which the accumulations can be withdrawn through a side door. Continuing, the air stream passes through steel-wool matting which removes the remaining foreign matter and from which the purified air is discharged directly into the work room. The matting becomes clogged only after many hours of grinding and polishing and is cleaned once every three or four weeks.

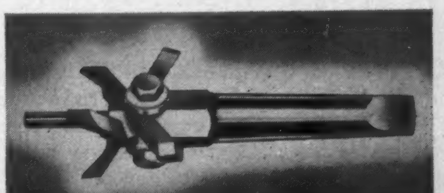
A modified form of the system just described, using cloth instead of steel wool as a filtering medium, is serving some of the grinding and polishing benches; air purifiers are installed on metal-plating apparatus; and in the room where the castings are poured, each of the furnaces is provided with a filter that reduces the dust and smoke to a minimum. These are only a few of the precautions that are being taken to prevent contamination of the atmosphere in the big windowless plant which is equipped with an air-conditioning system that has a capacity of 1,000,000 cubic feet of air a minute.

Adjustable Tool Cuts Holes in Metal

FOR cutting holes in metals, plastics, and other hard materials such as pressboard, Robert H. Clark Company has recently introduced a tool that, according to the manufacturer, is already helping to expedite the war effort in airplane plants and shipyards. The cutter has three adjustable, high-speed steel blades and is operated by an air or electric drill, or serves in conjunction with milling machines, lathes, or drill presses with which Morse taper or straight-shank tools can be used. There are six standard sizes suitable for cutting holes ranging from 3/4 inch to 4 1/2 inches in diameter and from 1/4 to 3/4 inch in thickness. Models for larger and deeper holes or for special materials are made to order. The tool is said to leave a smooth, finished hole in both flat and curved surfaces.

CLEAN-CUT HOLE

The adjustable cutter showing, left to right, the pilot, blades, and shank. Each blade is set precisely by measuring the distance between its tip and the pilot. A lead drill can be used in place of the latter. The tool at the right is being operated by an Ingersoll-Rand Multivane air drill and is cutting a hole in a thick steel plate.



Log of Our War Economy

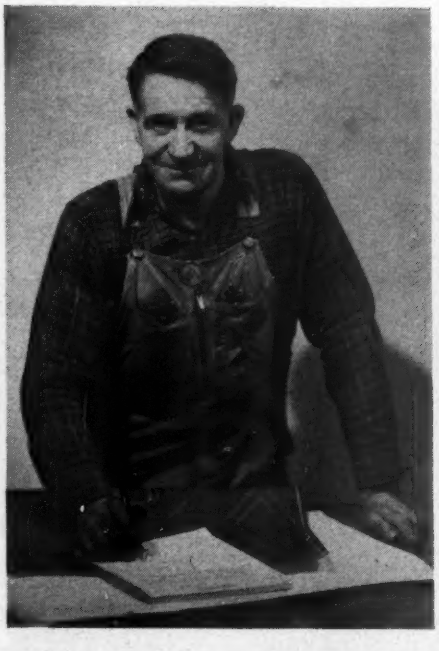
THE following paragraphs contain significant bits of information culled from official press releases sent out by the War Production Board.

JANUARY 24—Power plants on U. S. Bureau of Reclamation projects in eleven western states produced more than 7,250,000,000 kw-hrs. of electrical energy in 1942, and most of it was used for war manufacturing purposes. The output was 75 per cent greater than in 1941. By summer of this year their annual capacity will be 10,000,000,000 kw-hrs., or more than is generated in the State of Illinois.

JANUARY 29—Joseph L. Weiner, Director of the Office of Civilian Supply, has estimated that approximately $56,000,000,000 worth of goods and services would be required annually if the nation's civilian economy were maintained on a bedrock basis. This is about 32 per cent less than the 1941 consumption. Actually, civilians will receive some 23 per cent more than this minimum requirement in 1943. So far only metals and rubber have been cut to the so-called bedrock basis.

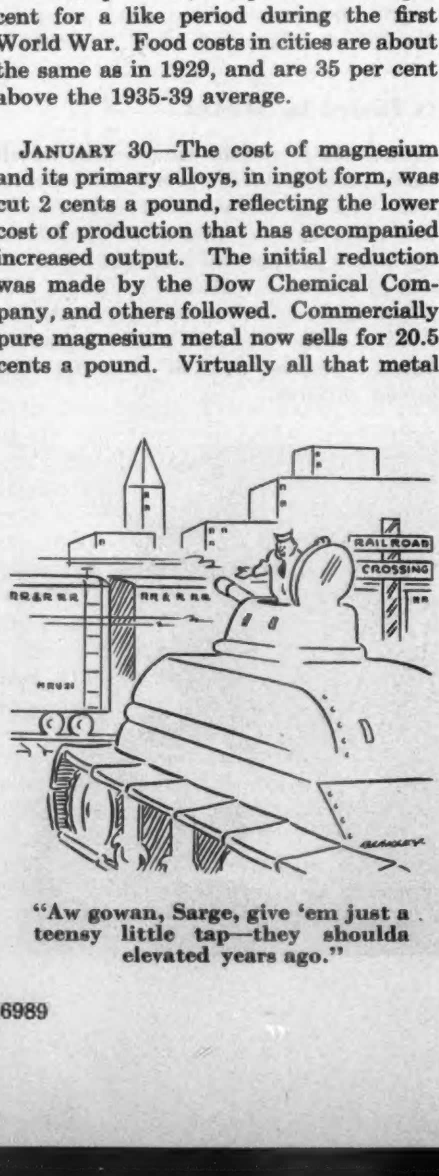
The cost of living rose 9 per cent during our first year of the war, Secretary of Labor Perkins has stated. The rise since the outbreak of fighting in Europe has been 22.1 per cent, compared with 35 per cent for a like period during the first World War. Food costs in cities are about the same as in 1929, and are 35 per cent above the 1935-39 average.

JANUARY 30—The cost of magnesium and its primary alloys, in ingot form, was cut 2 cents a pound, reflecting the lower cost of production that has accompanied increased output. The initial reduction was made by the Dow Chemical Company, and others followed. Commercially pure magnesium metal now sells for 20.5 cents a pound. Virtually all that metal and its alloys is going into war production. All but two of the domestic magnesium plants are owned by the Government.



IDEA CHAMP

Norman K. Stump, who helps produce self-sealing fuel tanks for U. S. warplanes at a Goodyear Tire & Rubber Company plant in Akron, Ohio, submitted 23 suggestions for improving shop practices last year and 21 of them were adopted. He received a cash award for each, plus a bonus at the end of the year. "Ideas as well as work will win the war," he says.



"Aw gowan, Sarge, give 'em just a teensy little tap—they shoulda elevated years ago."

JANUARY 31—During 1942, the U. S. Employment Service filled more than 10,000,000 jobs. There are still 25 kinds of skilled workers urgently needed in the war effort.

FEBRUARY 1—During the past fifteen months, the Board of Economic Warfare has diverted to the use of the United Nations $34,000,000 worth of materials and articles that were originally purchased by those interests in Axis or Axis-dominated countries. Included were 6,000 tons of raw rubber, 32,000 tons of iron and steel, and 18,920 automotive units.

FEBRUARY 5—If prices hold at present levels, the nation's expenditures for munitions and war construction from June, 1940, through 1943 will total around $157,000,000,000. It is computed that the sum would be $78,000,000,000 greater without price-control regulations.

FEBRUARY 6—Appealing to all divisions of the WPB to work together, Production Vice-Chairman Charles E. Wilson has estimated that the output of war materials can be increased 10 per cent by effective planning. One of the first objectives is to coöperate with procurement agencies to get orders booked with contractors promptly so that they may, in turn, schedule production effectively.

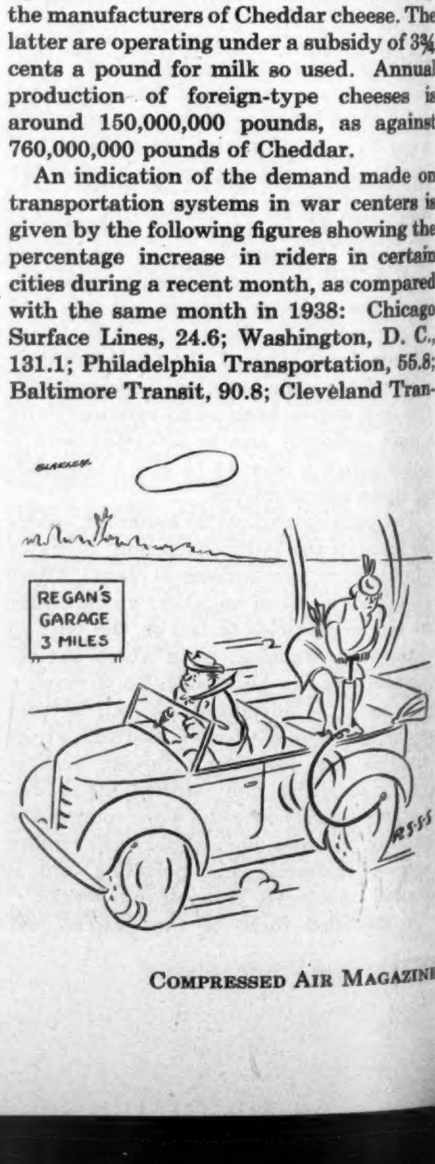
The greatest textile production in the nation's history is in sight as a result of an appeal to 519 mills to increase their output of essential types of materials. Textiles are used in the armed forces for numerous articles from parachutes to uniforms and from powder bags to tarpaulins, and also are required to keep the civilian population adequately clad.

FEBRUARY 9—The surprise announcement regarding shoe rationing started some "scare" buying of clothing and elicited a statement from Donald M. Nelson that supplies of wool are adequate and that there is no present intention of rationing clothing.

Employees in various branches of the oil and natural-gas industries were urged to stick to their jobs, which are considered essential to the war effort. In some places such workers transferred to war-manufacturing plants following the War Manpower Commission's recent statement concerning nondeferrable occupations.

FEBRUARY 10—Makers of cheeses of the so-called foreign kind were granted a price increase of three cents a pound to equalize the cost with that incurred by the manufacturers of Cheddar cheese. The latter are operating under a subsidy of 3¾ cents a pound for milk so used. Annual production of foreign-type cheeses is around 150,000,000 pounds, as against 760,000,000 pounds of Cheddar.

An indication of the demand made on transportation systems in war centers is given by the following figures showing the percentage increase in riders in certain cities during a recent month, as compared with the same month in 1938: Chicago Surface Lines, 24.6; Washington, D. C., 131.1; Philadelphia Transportation, 55.8; Baltimore Transit, 90.8; Cleveland Tran-



sit, 32.7; Charleston, S.C., 622.1; Wilmington, N.C., 522.3; San Diego, Calif., 336; Portland, Me., 236.4; San Antonio, Tex., 207.4; Savannah, Ga., 207.1; New York City, 2.3. Despite these increments, little new equipment will be available during 1943.

There is an acute shortage of railroad watches, and persons possessing one are urged to sell it to a jeweler or local railroad-watch inspector. Many railroadmen who have entered the service have taken their watches with them, and the production of new timepieces of this grade is not large enough to meet the demand.

Collection of household waste fats in December exceeded 5,000,000 pounds. Army cantonments yielded about the same amount, and naval establishments 1,000,000 pounds.

A Combined Copper Committee has been formed by the United States, United Kingdom, and Canada. It will assemble and coördinate information on the supply and requirements of copper and recommend means for increasing its production. A similar committee for steel was formed last December.

FEBRUARY 11—One hundred war contractors held 70 per cent of the dollar volume of prime contracts, or $59,557,-900,000 worth, at the end of November 1942. Eight concerns each had contracts for more than $1,000,000,000.

FEBRUARY 15—In a further effort to improve the transportation of petroleum products, WPB has authorized the construction of 200 additional automotive tank-trailer outfits. This brings the total authorization since last December to 1,092 units. Under this program of diverting short-haul movements from tank cars to tank trucks, 14,000 tank cars have already been released for longer hauls. Because the short-haul efficiency of trucks is much greater than that of cars, each new trailer unit is expected to replace from 6 to 11 cars, depending upon the length of the runs.

FEBRUARY 18—Ninety-seven per cent of the 1942 construction was for the war effort. It had a total value of $12,145,-059,000, or more than double the 1941 figure. Direct military construction during the year was more than three times that in 1941, and factory construction was 2½ times as great.

FEBRUARY 19—Lend-Lease Administrator Stettinius has said that 2,900,000 tons of war supplies have been sent to the Soviet Union. January shipments were 10 per cent greater than those of December. Most of them are getting through, no losses having been sustained in December or January. Although our help has been important, the Russian offensive is being fought primarily with weapons produced by the Soviets. Among the United States shipments that were mentioned as being of especial aid to Stalin's forces were: thousands of miles of field telephone wire, quantities of steel that have been used in making tanks, chemicals for bombs, and 682,000 tons of butter for wounded Russian soldiers in hospitals.

SAVES TIME AND FOOTWEAR
Workers in one of the Nash-Kelvinator war plants do not have to carry their gauges periodically to a central point for checking—the necessary equipment is brought to them on small trucks, like the one shown here. Five of these master checking stations make their respective rounds in the production and inspection departments 24 hours a day, and in that time check on an average 7,000 of the 35,000 gauges in use. By reversing the customary procedure, a saving of more than 1,000 man-hours is effected daily and machines are kept busy.

FEBRUARY 21—By stopping the manufacture of mechanical refrigerators, sporting goods, toys, and hundreds of other articles that are not essential to the war effort, annual savings are being effected of 2,000,000 tons of critical metals and a large but undetermined tonnage of other essential materials.

FEBRUARY 22—Copper scrap was declared to be the most pressing industrial salvage problem of 1943, although the scrap collection of iron, steel, and aluminum must be maintained at a high level.

The production of soft coal during the week ending February 13 was 12,200,000 tons. This was the largest weekly output since February, 1929. Production will have to be maintained at a daily average of 11,578,000 tons if the nation's 1943 requirements of 600,000,000 tons are to be met.

FEBRUARY 25—Two recent actions of the OPA were cited to show that wartime restrictions on civilians will not be imposed any longer than absolutely necessary. The first of these actions authorized "C" gasoline rations for workers that cannot get to their jobs with "B" rations. The second action permits any motorist to have his tires recapped with reclaimed rubber without going to his local rationing board for permission. As recapping takes less than half as much rubber as a new "war" tire, it is felt that this ruling will reduce the over-all rubber consumption.

FEBRUARY 27—Increased production and reduced absenteeism and accidents are reported from war plants that are serving their workers the balanced meals recommended by the Nation in Industry Program.

Fuel for Fighters

IN THESE days of civilian food rationing, it is consoling to the people at home to know that the American fighting man is better fed than ever before and that no other nation provides so generously for the inner man of its troops. In this connection it is also interesting to compare the U. S. Army rations of the past and present. An article in *Army Life* gives us illuminating information on the subject.

The Continental Army of 1775 didn't know what a calorie was. The standard daily ration consisted of plain fare and bare essentials: 16 ounces each of beef, flour, and fluid milk; 6.857 ounces of dry peas; 1.143 ounces of rice; and a quart of spruce beer. The latter item was replaced during the War of 1812 with a gill (about 4 oz.) of rum. In every war up to the present one, each of our soldiers was, in addition, given a daily allowance of soap and candles. Washington's Army had no field kitchens; the food was issued uncooked and the men prepared it over campfires.

In the Mexican War the daily allowance of beef was increased to 20 ounces and that of flour to 18 ounces. Dry beans were substituted for peas, and the allowance was cut to 2.4 ounces. Green (unroasted) coffee made its appearance in the amount of 0.96 ounce. Sugar (1.92 oz.), vinegar (0.16 gill), and salt (0.64 oz.) were likewise added to the diet. In 1835 the rum ration was abolished and, since then, the American doughboy has been primarily a coffee drinker. His present daily ration of the fragrant bean is 0.96 ounce, or considerably more than double the quota a civilian gets from his allotment of a pound every six weeks.

During the Civil War, yeast powder, black pepper, and four cigarettes a day, or their equivalent in pipe or chewing tobacco, became standard items. The allowance of beans was increased to 2.56 ounces, and the coffee, vinegar, and sugar rations were raised, while the amount of soap was doubled. However, food was not always available for issue and the soldiers frequently had to forage for some of their supplies. In fact, the established custom in those times was for armies to obtain much of their subsistence "on the country."

In the Spanish-American War, potatoes entered the kitchens and have become one of the standby items in the fighting man's diet. Baking powder replaced yeast, the allotment of candles was almost quadrupled, and "hardtack" disappeared from the garrison ration, although it was retained in the field ration. The potato ration jumped to 20 ounces daily in the First World War, and prunes, sirup, evaporated milk, ground cinnamon, butter (0.5 oz.), lard, and lemon-flavoring extract were added. The sugar ration was increased to 3.2 ounces, while the consumption of coffee, baking powder, and vinegar fell off.

Today's garrison ration allowance has been greatly expanded as regards variety of fare. It contains 39 items, among which are bacon, cheese, chicken, cocoa, eggs, jam and preserves, macaroni, onions, pickles, pork, and prunes. Canned goods include apples, beans, corn, peaches, peas, pineapple, and tomatoes. On holidays the provisions are even fuller. For example, the 1942 Thanksgiving Dinner included 1¾ pounds of turkey for each man.

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A 1,200,000-Hp. Surprise

HOW well censorship of news that might aid the enemy is working may be judged from the fact that a hydroelectric development, that virtually duplicates Boulder Dam in size, has been brought well along towards completion in Canada with not a hint of it being given to the outside world. A surprise announcement of the new power colossus was made at the end of January.

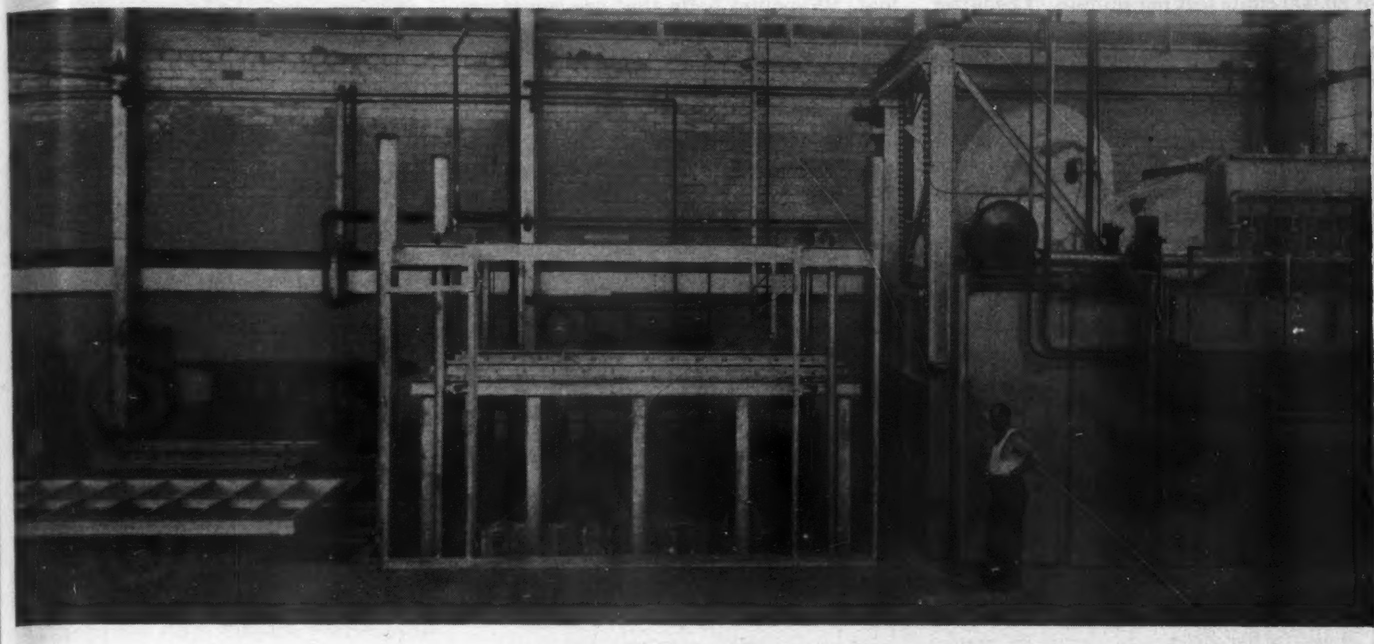
The plant is situated in northern Quebec on the Shipshaw River, a tributary of the Saguenay. It is not far from the aluminum-producing center Arvida, and the power will be used to help increase the output of the metal from 50,000 to 500,000 tons a year. The Aluminum Company of Canada financed its construction, and the cost of $65,900,000 will be defrayed by contracts for the sale of aluminum to the United States and Great Britain.

Upon completion, the powerhouse will contain twelve generating units, each of which will develop about 100,000 hp. Already two of them are in operation. The plant is claimed to be remarkable for its high percentage of firm or continuous output. Even with the flow of water at its lowest level, the generators will produce 970,000 hp. This is due to the fact that the feeding stream flows out of a 400-square-mile lake which, in turn, receives the run-off from 28,000 square miles of land. This latest development of the Saguenay River system gives it aggregate generating facilities of 2,040,000 hp., which is said to exceed the total of any area of equal size in the world.

Work on the Shipshaw power project was started on October 1, 1941, and was carried on through two winters in a section where temperatures down to 50° below zero Fahrenheit are not uncommon. At the peak of activities, 10,595 men were employed and the payroll amounted to $1,771,000 a month. Some idea of the magnitude of the job may be gained from the following construction quantities: total material excavated, 5,731,000 cubic yards; concrete used, 1,024,000 cubic yards; reinforcing steel needed, 14,109,120 pounds; dynamite consumption, 3,240,000 pounds; concrete-mixing capacity, 7,800 cubic yards a day.

Details of the work will probably not be available until the end of the war. According to the meager description so far released, the Shipshaw has been diverted and runs through a man-made gorge 1½ miles long and of sufficient width and depth to float an ocean liner. The blasting of a block of solid rock between the river and the canal at the intake point is said to have required a charge of 83,000 pounds of dynamite.

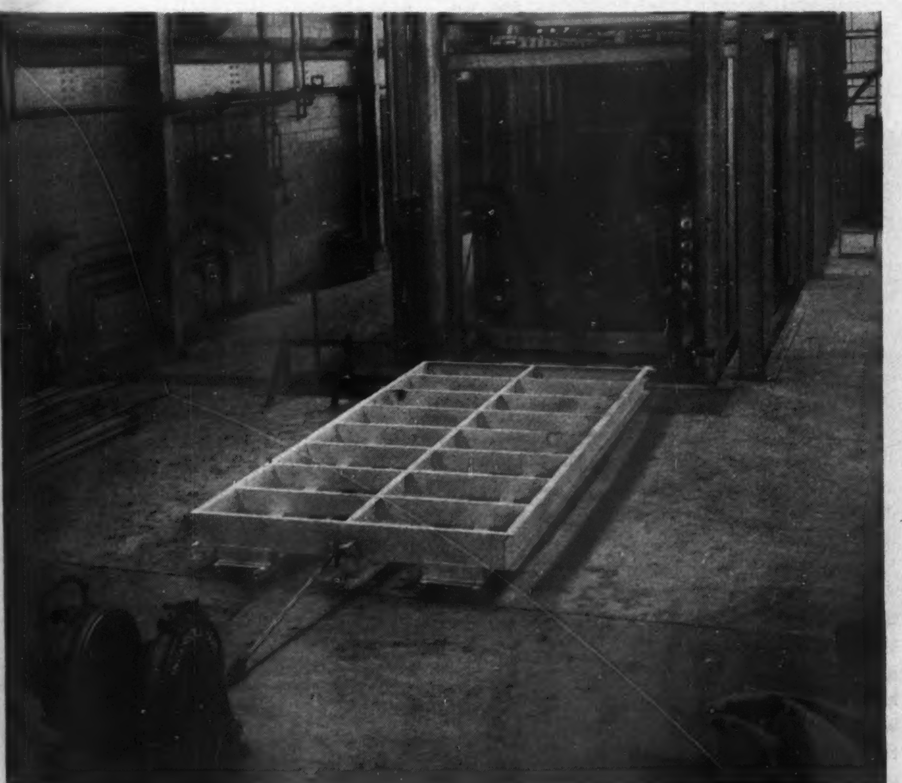
High-Speed Loading and Quenching System for Heat-Treating Furnace



THE COMPLETE SET-UP

This picture shows the elevator with a charge of aluminum castings that has been withdrawn from the furnace and is being lowered into the quenching bath. At the left is an empty platform that would normally be loaded at this stage ready to enter the heat-treating chamber by way of the top of the cage as soon as it reached bottom. Air cylinders serve to raise and lower the elevator, and an air-operated hoist is used to haul the platform into the furnace and out back to the starting point after a predetermined stop in the quenching tank.

NEED for greatly increased production of aluminum castings is responsible for the installation in a Cincinnati foundry of a heat-treating furnace that features a high-speed materials-handling and quenching system. The unit is believed to be the first of its kind in service in this country, and was designed and set up by the Despatch Oven Company. The cycle of operations is a continuous one, and is made possible by an elevator with two loading levels that rides up and down in a sunken quench tank in front of the furnace.



MATERIALS-HANDLING EQUIPMENT

End view of the elevator, showing the air-operated Utility hoist that does the loading and unloading. The cage is level with the foundry floor ready to discharge a platform of quenched castings.

Two load platforms are used to keep the charges moving. When one is ready to leave the heat-treating chamber, it is pulled out on to the lower level of the elevator over a series of carefully aligned rollers by means of an Ingersoll-Rand air hoist that serves as a winch and is immediately dropped into the quenching bath. With the elevator in the down position, the top of the cage, which is also provided with rollers, is on a level with the furnace floor and serves as a track for the second platform which has been loaded with castings in the meantime.

The elevator is built of heavy structural steel and is adequately reinforced to support the platforms, each of which may carry a gross charge of more than 11,000 pounds. It is raised and lowered by two 12-inch diameter air cylinders with a stroke of 108 inches. These are operated by a hand valve and controlled so as to drop the load into the quench tank at a rate of 60 feet a minute. Air at a pressure of 80 pounds is used. The quenching section is 17 feet long, 8½ feet wide, and 11 feet high. The tank, which is constructed of ¼-inch copper-bearing steel plate, is provided with a suitable drain and overflow, and the bath is heated with two Eclipse burners.

The heavily insulated furnace is heated indirectly by gas and contains nine return-

bend radiant tubes through which the heat is circulated by a fan with a capacity of 20,000 cubic feet per minute. The latter is operated by a 20-hp. motor. The flow is both vertical and horizontal, and the temperature within the entire work chamber is uniformly maintained within 5°F. plus or minus. No combustion gases enter it, thus permitting all types of aluminum alloys, including Nos. 355 and 356, to be properly heat-treated.

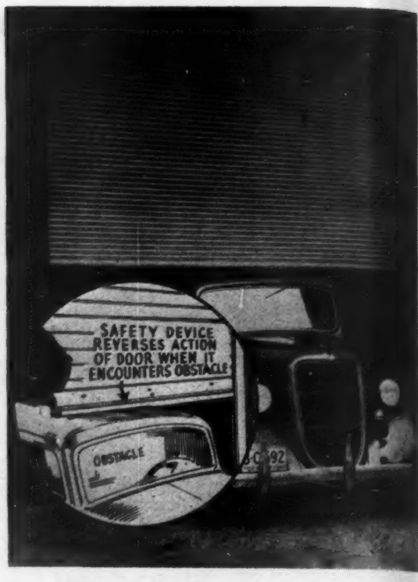
It is reported that when the materials-handling system was first put in service it took about half a minute to withdraw and to quench a load of 4 tons of castings. Now the work is done in 25 seconds, and it is believed that, when the operators have become fully experienced, the time element will be still further reduced. The whole cycle, which formerly required from two to three hours, is completed in five minutes.

Bolts of New Design

NUTS and bolts for steam turbines and other heavy duty can be made 40 per cent stronger than they now are by giving them broad shoulders and tapered bodies. This statement was made recently by Dr. Miklos Hetenyi of the Westinghouse Research Laboratories at a meeting of the American Society of Mechanical Engineers. His new design is the result of investigations with 5-inch-long plastic models, counterparts in miniature of 5-foot, 500-pound bolts that are sometimes subjected to 1,000,000 pounds pressure as a turbine gets hot and expands. To put the models under a corresponding strain, a 30-pound weight was suspended from the bottom of each for a period of three hours during which the bolt was kept at a temperature of 250°F. to bake in the resultant stresses. After cooling, slices were cut 1/8 inch from the center of each model and placed in a polariscope—an instrument in which pictures were taken of the rainbowlike stress lines made visible by passing polarized light through the transparent sections. By studying nuts and bolts of different designs in this manner, Doctor Hetenyi discovered that ordinary nuts and bolts concentrate their stresses at a few places, the bottom threads carrying most of the load, while the tapered type, in which the lower threads of the nut do not fit flush against the bolt, distribute them more evenly.

Safety Device for Doors

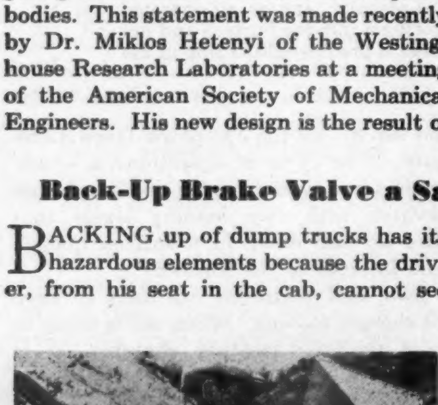
INJURY to a car or person by a descending garage door or the like is obviated, it is claimed, by the use of a new safety device that has been announced by the Kinnear Manufacturing Company, makers of motor-operated rolling doors.



It consists of a weatherstrip at the bottom of the door that is filled with compressed air. Upon contact with an object, the strip is compressed and forces air through an impact switch, causing the door either to reverse its travel and return to the fully open position or to stop, depending upon the means by which it is connected to the control circuit. Action is said to be so positive even under the slightest pressure that a person can let a door come down on his head with no discomfort. The company has recently built a door of this kind that serves as a passageway for a 120-ton overhead traveling crane and forms nearly the entire rear wall of a 7-story structure.

Back-Up Brake Valve a Safety Feature of Dump Trucks

BACKING up of dump trucks has its hazardous elements because the driver, from his seat in the cab, cannot see everything that goes on behind him. To lessen the danger, such vehicles are fitted with horns, bells, or whistles, both front and rear, in compliance with Construction Safety Order 1167 (b) of the Industrial Accident Commission, which further specifies that the signals be sounded before backing up. However, where operations are noisy, such warnings may go unheeded.



CAN SEE WHAT HE'S DOING
This picture shows the cab end of a Los Angeles County Road Department dump truck with the driver in position for unloading and with his hand on the lever of the back-up brake valve.

To provide still greater protection, the Los Angeles County Road Department has devised a back-up brake valve in its shops that permits the driver to travel in reverse and dump his load while standing on the running board of his vehicle. This auxiliary is a feature of all the department's heavy dump trucks, and is placed just outside of the cab and with the operating lever within convenient reach of the driver's right hand, as the accompanying illustration shows. It is connected through hose and piping with the air lines of the regular foot brake, but does not interfere with the latter's normal functioning. The trucks so equipped have six reverse speeds and can travel approximately 18 miles an hour in reverse gear—that is, as fast backward as forward. Experience has proved that the brake valve is not only a safety measure but also an efficient means of truck control while backing and unloading. It is easy to install and does not require extensive changes in the regular braking system.

New Ore-Handling Method

WESTERN mine operators, reports *Miner and Prospector*, are interested in a method of moving crushed materials such as ore and aggregates through pipe lines. The system was designed and patented by C. Erb Wuensch, San Francisco mining engineer, and is said to be an adaptation of his sink-and-float process now widely used in lead-zinc operations and coal fields in separating waste from values.

Roughly, the Wuensch method operates on the air-lift principle. It calls for a 12-inch vertical pipe extending from the surface to a point below ground where ore is extracted. The material is crushed to less than 3 inches and passed through a valve-control chamber to the bottom of the pipe. Centrally disposed in the latter is a smaller pipe through which a heavy magnetic medium (magnetite, etc.) at proper density is directed from the surface. The fluid is under pressure and forces the crushed ore up through the annular space in a steady stream. It also acts as a lubricant and prevents packing and caking in the pipe line. The magnetic medium is stored in a tank and can be used over and over again.

Industrial Notes

Peanut oil as fuel is being used experimentally on the first section of the African Trans-Sahara Railway which was opened to traffic this year, reports *Foreign Commerce Weekly*. On trial runs, three trains are said to have reached an average speed of 65 miles an hour.

According to *Foreign Commerce Weekly*, gasoline for tanks and planes is being carried in containers made of specially treated cardboard. Being insulated, the material has in some cases been found to be safer than tin because it offers greater protection against the dangers of contact with electric currents.

Under the name of Firepel, the Albi Chemical Corporation is producing a fire-retardant solution for wood that is applied to the unfinished material by brush or spray. The liquid is absorbed by the wood and is therefore more resistant than an insulating film to the destructive distillation of the wood. It is further claimed that the chemicals are nontoxic, to have fungicidal properties, and that they do not corrode metals with which they may come in contact. Two coats are recommended for best protection.

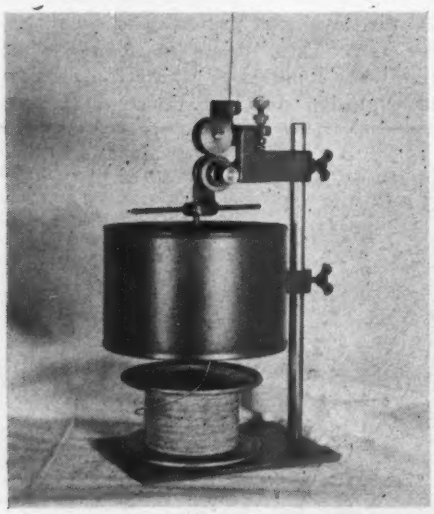
It is reported from abroad that British engineers have produced a new plywood that has been named Hydulignum. It is being used to manufacture airplane propellers and is made of veneers of birchwood, each 1/36 inch thick, treated with Formvar, a special resin. Weighed packs of about 60 of these plies are subjected to heat and pressure from top and bottom and, in addition, to lateral pressure. Herein the process differs from usual practice. This 2-way compression reduces the thickness of the stack to 1¼ inches and provides a material that is said to be more homogeneous and therefore stronger than ordinary plywood. Its increased density permits the making of thinner blades that have less tendency to flutter and vibrate. Another advantage is interchangeability. Heretofore, when one blade of a 3-bladed propeller was damaged, all had to be changed to assure correct balance. Now, only the injured member needs to be replaced.

Diamonds and diamond dust are used in wire-drawing, the former for wire of small diameter and the latter for larger sizes. The dust is a by-product of the first-named operation and is obtained by crushing the stones that are no longer suitable for the work for which they are designed. After several thousand pounds of wire has been drawn, the holes in the diamonds through which the wire passes become oversize. Then the stones are either redrilled or they are converted into dust that serves to polish dies of tungsten carbide (one of the hardest compounds yet developed) by which wire and rods ranging from 0.0641 to ⅞ inch are drawn. The dust can be used over and over again, but until of late its recovery has presented something of a problem. Together with oil, tungsten carbide, cobalt particles, bristles, and bits of cloth it falls into a receptacle in the course of the polishing, and is ordinarily separated from the waste material by the use of large quantities of acids which destroy everything but the diamond dust. By a new process, developed in General Electric's Schenectady works laboratory, reclamation is effected by technicians in half the time than formerly and with small amounts of chemicals.

Linoleum that is said to prevent the building up of charges of static electricity is announced by Congoleum-Nairn, Inc. It was developed primarily as a covering for tables and floors in plants where powder is handled or where the presence of explosive dust, or mixtures such as

ether and oxygen in operating rooms, constitute a hazard. The material is claimed to be resistant to repeated washings with hot and cold water and to most acids. It comes in rolls 6 feet wide and is laid like ordinary linoleum.

Unreeling fine wire from a spool to a winding machine, for example, becomes child's play, it is claimed, by the use of the Uni-Flow De-Reeler announced by The Globe Tool & Engineering Company. The



wire is unwound with the spool stationary and is guided upward through a tube to a tension-wheel assembly, whence it passes to the point of application. The device is available in two sizes for supply spools of 3 and 4 to 6 inches and is recommended for wire ranging from No. 26 to 42 gauge. According to the manufacturer, the operation is effected at high speed without kinking, breaking, or stretching the wire, damaging insulation, and overflow even with irregular, intermittent feed.

With SealKure it is not necessary to use burlap, straw, cotton pads, etc., for curing concrete, says Lyons & Rood, makers of the new solution. The latter is applied by spraying as soon as the surface water sheen has disappeared and is said to have a moisture-retention factor of more than 98 per cent. It contains a die that leaves no trace in a few days but shows what areas have been treated and thus prevents duplication of effort and wastage. Except in cases of extreme atmospheric conditions, one gallon is sufficient to cover 200 square feet. The product has, it is claimed, been approved by the U. S. War Department, Office of the Chief of Engineers.

Most of us know what to do when a person's clothes catch on fire; but how often, except possibly at home, is a blanket or the like available with which to smother the flames. To remedy this situation in industry, especially where work is done under conditions that represent a fire hazard, the C. Walker Jones Company has put on the market what is called the Jomac Fire Blanket. This is described as a specially knit, flexible covering that is packed ready for immediate use in a flameproof container that may be hung alongside a fire extinguisher or included in the equipment of first-aid stations or air-raid wardens. The blanket is said to be 100 per cent flameproof regardless of the intensity of the fire.

To save ammunition, U.S. Artillery gun crews do their practice shooting on a miniature range with regular gunsights and laying mechanisms, but with small-caliber projectiles. Today, through the improvement of the artillery trainer by Capt. H.E. Mikkelsen, U.S. Army, still further economies are being effected by dispensing with the use of powder to propel the missile. This is now done with compressed air or gas contained in a chamber that is connected to a tube by a quick-acting valve. The other end of the tube is attached to the gun and is sealed by the ball projectile to be fired upon release of the propulsive medium. An added advantage of this system is that it obviates fouling of the gun barrel.

Rex is the trade name of a bearing metal that meets the Government's tin-limitation order and is a product of the National Bearing Metals Corporation. Its properties are said to compare favorably with those of tin-base babbitts and are listed as follows: tensile strength (pounds per square inch) 8,200; elongation in 2 inches, 1.2 per cent; reduction in area, 1.8 per cent; compressive strength, 17,500; specific gravity, 9.6; Brinnell hardness, 25; pouring temperature, between 625 and 675°F. According to the maker, the metal is a satisfactory substitute for high-tin-base babbitt in most present-day uses if the lining is properly applied and the bearing is carefully fitted and lubricated.

Walter Kidde Photo

AUTOMATIC FIREMAN

The small gadget being examined by a technical sergeant in the U. S. Air Force is designed to serve as a fire warden on airplanes. It is an impact switch provided with a trigger arrangement that is set to function when a machine crashes—any lesser force such as would be encountered in flying or in landing on a bumpy field leaves it inoperative, it is claimed. When set off, the safety device automatically discharges liquid carbon dioxide into the engine compartment, filling it with clouds of flame-quenching vapors.

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